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CALICO ENGRAVING:

A PRACTICAL TEXT-BOOK

FOR STUDENTS, DESIGNERS, AND ALL ENGAGED
IN THE TEXTILE INDUSTRY.

BY

WILLIAM BLACKWOOD,

LECTURER ON ENGRAVING DESIGN FOR CALICO AT THE ROYAL TECHNICAL
COLLEGE, GLASGOW, MANAGER, ENGRAVING DEPARTMENT,
THORNLIEBANK PRINT WORKS.

With 278 Illustrations.

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PREFACE.

The subject of engraving from its breadth and comprehensiveness is one that is applied to many industries, and text-books are provided dealing with some of its phases, but it is not within the knowledge of the writer that the important branch of the Textile Industry has been treated in English literature even in an elementary manner.

The absence of such a text-book has been felt, and frequently remarked upon by students of the subject, as well as the highly skilled body of designers whose work forms so important a feature in promoting the interests of the manufacture of calico.

Emboldened by numerous requests in this direction, the author has here ventured to extend the lectures delivered by him on Engraving design for Calico at the Royal Technical College, Glasgow, in the hope that this book will prove instructive, not only to the artisan directly engaged in the business, but also all those who have an influence on the Calico trade. As will be noticed the technicalities of the subject have been entered into rather fully.

I have pleasure in expressing my indebtedness to those who assisted in preparing some of the illustrations, and to George Moulton, Ltd., Manchester, who kindly supplied the blocks of the principal machines; also to the publishers for their advice and consideration.

WILLIAM BLACKWOOD.

BARRHEAD,
GLASGOW, *September, 1913.*

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CALICO ENGRAVING.

CHAPTER I.

HISTORICAL INTRODUCTION.

Definition and Origin of Engraving.—Engraving has been defined as the act, art, or practice of producing figures or designs on metals, etc., by incision, or corrosion, for the purpose of subsequent reproduction on paper, cloth, or other material. The word has obtained a conventional meaning, altogether apart from its etymology, and is applied to the pigment-bearing portions of a cameo plate equally with the incised or corroded lines of an intaglio.

The origin of Engraving has been lost in antiquity. Reference is made to it as far back as the liberation of the Jews from Egyptian bondage, when Moses received the command to "make a plate of pure gold, and engrave upon it; also two Onyx stones, and engrave the names of the Children of Israel, according to their birth." Here may be said to be the elements of gem and seal, as well as plate-engraving.

In India the art seems to have been practised before the Christian Era, and in England prior to the Conquest many of the military accoutrements bore intaglio engraving. In the Museum at Oxford there is a finely engraved gold jewel which belonged to Alfred the Great, and the engraving of sepulchre brasses formed an industry of no mean importance in the twelfth century.

Spread of the Art with the Invention of Letterpress Printing.—On the invention of printing, other phases of engraving came rapidly to the front. The Monks of Old Europe early recognised the potent influence of graphic illustration, hence the xylographic method of book production of the fourteenth century with its depiction of various phases of Omnipotence. The pages of these books generally consisted of one engraved block, from which the print was taken by impression.

The earliest dated example of this is the picture of St. Christopher, bearing an inscription, the English translation being, "Each day the mind of St. Christopher was consecrated."

Transition from Wood to Metal.—From wood it was an easy transition to metal engraving, and about the year 1452 the process was invented by Thommasso Finiguerra, a Florentine goldsmith. The new art was eagerly taken up by Botticelli and others, and the first book printed in Rome, Ptolemy's *Geography*, was illustrated with Niello plate-engravings after this fashion.

Sixteenth Century Engraving.—In the sixteenth century Albrecht Durer appeared, and his great talent enlarged the possibilities of the Engraver's art, and carried it to a degree of perfection, previously unknown, by the discovery of the art of etching. On close examination, however, his work bears evidence of having all been done in one biting, clearly proving that the art of stopping-out was not then understood. Harmony of effect was thus to a great extent lost, and a somewhat harsh unfinished appearance given to an otherwise excellent work.

Introduction into England.—The stipple effect in engraving was the discovery of Agoftino de Mufio, and with the mezzotint process, invented in Germany and introduced into England in 1660 by Prince Rupert, grandson of Charles I., the various methods of engraving may be said to be completed, and the way paved to modern principles and adaptation.

In Britain, despite the early influx of workers from France, Flanders, and Holland, the art never flourished until within the last century; yet during the last twenty years the progress made has certainly equalled, if it has not excelled, the best work of the foreign masters, and the names of Whistler, Muirhead Bone, and D. Y. Cameron are closely associated with the advance made.

Photography, in conjunction with etching, now holds the field, and beautiful results are obtained by the use of the camera screen, to which fuller reference will be made in a later chapter.

Engraving for Cloth Printing.—An examination of the various methods referred to only serves to show their general unsuitability for calico work; but it is plain that if the same scientific research and enterprise had been evinced in calico engraving as has been shown in other directions, newer and speedier methods might have resulted in connection with engraving as applied to cloth decoration.

It has been said that the birth-place of the art of the western world was the Plains of Pamir, and to India we must also look for the earliest examples of staining, or printing on cloth. Coming westward it reached Egypt, and Pliny in his *Natural History* describes a

method adopted by the Egyptians. Asia Minor and the Levant also early practised the art, which did not reach Europe till the seventeenth century.

First Printwork in Britain.—In 1690, the first printworks was established near Richmond in Surrey, and in 1738 the industry was commenced in Scotland, and took firm hold in and around Glasgow. Not until 1764 was it introduced into Lancashire, which has long been the chief centre in Great Britain, and whose production of printed fabrics is unequalled by the combined output of all other centres in the world.

Printed cotton goods at this early stage received the keenest opposition from the silk weavers of Spitalfields, but this retardment was, to a large extent, relieved in 1831, when the burden of protection was taken away.

Earliest Methods.—In those early days the printing of cloth was done in primitive fashion. Engraved blocks of sycamore wood were first daubed over with a colour pad, and then struck on to the cloth. The parts of the block intended to form the impression were left in relief, the surrounding portions being cut away to a depth of fully a quarter of an inch. In the finer classes of work the pattern was formed on the wood blocks by means of small pieces of copper, or brass, ingeniously shaped to the forms of the design, and driven into the block, all intersections being then filled up with felt, or hat as it was termed. A separate block was required for each colour.

The Toby.—An improvement was shortly afterwards introduced, however, in what was called the Toby, or flat box, divided into as many compartments as there were colours in the pattern. These compartments were connected by means of tubes with bottles filled with the various colours, and by means of a sieve the colours, on gentle pressure being applied, were communicated to their respective compartments as required. On the surface of the Toby the different colour divisions were walled off with pitch. The block to be printed was then applied to the Toby, and all the different colours at one operation transferred to the cloth.

Flat Press.—In this process the patterns were engraved intaglio on flat copper plates up to about 3 feet square. Upon this plate the colour was spread, the excess being cleaned off by means of a "doctor," as in the present machine printing. The colour remaining in the engraving was then crushed on to the cloth.

The Perrotine.—In 1834, a block printing machine was introduced and named after the inventor, M. Perrot. The colour-carrying projecting or raised parts of wood or metal blocks are pressed against

the calico, through the agency of springs which imitate the elastic pressure of a workman's hand. Each block received a coat of colour from a woollen surface smeared after every contact with a mechanical brush.

Cylinder Printing.—In 1783 a machine for cylinder printing was introduced by Thomas Bell. All the engraving was executed by hand on copper cylinders. The machine did not take the place of block printing to the extent at first anticipated, because in 1840, fifty-seven years afterwards, statistics show that only 416 machines were at work in England, while 7,873 tables for blockwork were still in use. There were in all 93 firms, from the leading house at Broadoak, Accrington, with 320 tables, down to a firm with nine tables at Chadwick, near Stockport. In Scotland there were 81 machines and 5,751 tables in use by 66 firms, ranging from 330 tables at Denovan to five tables at Waterside, near Kilmarnock. Ireland had at this time seven firms with 19 machines and 584 tables.

Introduction of Mill Engraving Machine.—Previous to the introduction of the Mill engraving machine, the cylinders were engraved altogether by hand in the same manner, and with similar tools as those used in the ordinary copper plate engravings. Some doubt seems to exist as to the exact date when this system of transferring engravings from one surface to another by means of steel roller dies was introduced, but the earliest record is that contained in Ure's *Dictionary of Arts, Manufactures, and Mines*, which gives the invention as that of Jacob Perkins, of America, and applied to practical use by Mr. Lockett in the year 1808, although the Frenchmen claim the invention as that of Gormetz, of Mullhouse, in 1828.

Ribbon Rollers.—Prior to the introduction of the Mill engraving machine and the present methods of producing rainbow, or *ombrè*, effects, these were obtained by means of the ribbon roller, the invention of John Mercer, a pioneer in the calico-printing industry, whose name is a household one as the inventor of the process of mercerising cotton cloth.

The ribbon roller was a wooden cylinder about 6 inches in diameter, having the blanks grooved out to a depth of about five-eighths of an inch, and run in a colour box like the cylinder. The projections on the roller just touching the colours were impressed on the cloth as it passed over the upper part of the roller. Three cylinders or more might be used, each carrying different colours; the second and third overlapped the first, and the colours thus blending produced the requisite rainbow or shaded effects. This method is now, however, superseded by the present day *ombrè* effects obtained from the copper cylinders.

Introduction of Pentagraph Engraving Machine.—The earliest record to be found of the introduction of this most useful machine for calico engraving is by a man named Dewerill in 1834. It was some twenty years later before any decided improvement in the methods of engraving took place, but with these inventions came cheaper methods of engraving and the ultimate success of cylinder printing.

Great perfection has now been obtained in the construction of the Pentagraph (or reducing engraving machine) and its accessories, principally by the attention given to it by George Moulton, Ltd., of Manchester.

Difficulties in Calico Printing.—The engraver and printer have three difficulties to contend with:—First, the infinite varieties of cloth used in printing; second, the variety of methods in printing; third, obtaining equally good results on the various grades of cloths by using, with a view to economy, the same engraved cylinders.

Here enters the question of quality and cost of engraving. Mill engraving undoubtedly stands first in quality, and, although more expensive in the initial stages, gives the best results in all classes of garment printing. Further, the repairing of the rollers for repeat orders by utilising the original tools can be quickly and cheaply executed.

Hand engraving stands next in quality. Here, the style of design is usually of the large repeat description, which would not be economical to do by the Pentagraph, and impracticable by the Mill engraving machine.

Pentagraph engraving takes the third place, the design being usually of a smaller character, the repeats of which are scratched simultaneously on the cylinders previously coated with an acid-resisting varnish.

Process Engraving, which is being rapidly pushed to the front, is a newer method which, for economy and expedition, is utilised for many designs of a pictorial or large floral character.

CHAPTER II.

RELATIVE TO CALICO DESIGNING.

The Three Principal Points in Designing.—While it is not within the scope of this treatise to specialize in regard to the art of designing, a few hints in connection with the principal points to be observed will lead the engraver to more intelligently interpret the design which he is about to engrave, by placing himself in harmony with whatever conception the designer had in view.

A designer then should have three principal points before him :—

1st. *The idea or meaning.* By having a fixed object in view.

2nd. *The practicability of that idea.* In regard to what will suit the market, and sell well.

3rd. *The colour scheme.* So that various suitable combinations can be made up out of the same design.

The art of designing suitable for calico consists in expressing oneself within certain limits. For the garment trade the designer is bound down to make out the repeats to a section of from $14\frac{1}{2}$ to 16 inches on the perpendicular, although he is sometimes tempted to over-ride this boundary in regard to repeat, and, therefore, disappoints salesmen when his beautiful conceptions are place into practical working order.

Geometry, the Basis of all Patterns.—The simplest of all patterns is the stripe, or line. Of lines there are two kinds, the straight and the curved, and from these an immense variety of beautiful geometrical patterns can be worked up by the designer, and also by the diemaker, when he has a good knowledge of geometry. It is said that this study is simple enough for the child, but it is by no means to be despised by the designer whose soul is not above pattern. When practised it becomes apparent that a vast range of patterns can be built upon the simple ruling of straight lines, forming squares, oblongs, diamonds, triangles, etc.; also with the curved lines forming segments. The friendly way in which these figures unite to form a complex and ingenious variety of patterns accounts for the persistent use of such units in floor designs, tile work, and window lattice work.

The insistance upon a geometric basis to form design may seem like dogmatism, but it must be recognised that all patterns for repro-

duction by mechanical means must have a geometrical basis, it being quite impossible to design without it.

The various plans of construction upon which stress has been laid can be more plainly observed in geometrical than in floral patterns, but the one will be found to repeat as geometrically as the other, and on precisely the same lines.

Hints on Drawing.—The importance of being able to draw well is the first consideration for floral design, and the best method to acquire this art is to begin with simple ornament, and follow on with a study of plant form in all its aspects. For example, take a wild rose; the bud, leaf, stem, the thorns, and the full blossom in various positions should be carefully and minutely studied. By this means the student develops a knowledge of plant life which will give him every opportunity of building up an interesting and useful design.

The idea being formed and the limitations of the pattern considered, you then proceed to set out the necessary repeat lines, and rough out the pattern on tracing paper, sketching in the principal masses, or parts, on which the eye rests. This might be termed the "eye" of the design. Having got these points proportionately spaced, the secondary effects, which naturally will be lighter and less important, are now attended to.

The practicability of the idea will now have taken shape, and if the effect is not pleasing to the eye, by reason of irregularities, or want of proper balance of masses, then the design must be gone carefully over, and these blemishes rectified.

The sketch is then outlined on the back (presuming it is on tracing paper) with a delicate pencil line, and carefully "rubbed down" by means of the thumb nail, or small burnisher, on to the paper on which it is to be coloured. In the case of a coloured surface paper, the sketch is usually outlined on the back with sketch white, and the impression transferred as already explained.

Superpose Effects.—The colouring is now proceeded with, and at this stage everything depends on the particular style for which the pattern is intended, and considerable skill is required to thoroughly understand the requirements of the various markets. If "fall-on" or superpose effects are to be shown for white or tinted ground printing—*i.e.*, one colour falling on another to produce a different effect, such as red on pink producing a mid effect, red on green to produce a chocolate, blue on yellow to produce a green, pink on yellow to produce an orange, the designer requires to be careful, and use them in a very judicious manner, for the following reason:—On the original design the general effect may be excellent, but should

the merchant be desirous of having a varied range of colourings out of the same pattern, many of the effects will be muddy and unpleasant to the eye. It is, therefore, advisable, before using "fall-on" effects to any great extent, that the merchant be consulted regarding the combinations likely to be adopted.

The foregoing hints on drawing and colouring in regard to design will prove useful to the apprentice who desires to excel in sketch-making.

CHAPTER III.

SKETCHMAKING.

METHOD OF PROCEDURE FOR GARMENT DESIGNS.

Definition.—By this term is embraced the preparing of plans, sketches, and zinc plates for the various styles of engraving. Various tools are required for this purpose, details of which are enumerated under sketchmaker's outfit (see fig. 1).

No. 1. *Steel Compasses.*—From 9 to 10 inches long with adjustable wing screw on leg, also at end of sword. They are used for setting out plans or zinc plates.

No. 2. *Spring Dividers.*—Made of steel, usually in three sizes; large pair about 9 inches, medium about 6 inches, and a smaller pair about 3 inches long. They are used for marking off divisions on plans, and small divisions on zincs, the spring giving great security and correctness for subdivisions.

No. 3. *Case of Spring Bows.*—Each of these instruments is about 2½ inches long. The needle points are used for fine setting out on paper. The pen circlers are also used on paper, and for very fine work on zinc. The pencil circlers are suitable for paper alone.

No. 4. *Colour Saucers.*—Made of glazed earthenware in two sizes about 3 and 2 inches in diameter, one-half dozen of each being sufficient. The larger size is used for the more common colours, and the smaller one for special colours.

No. 5. *Sable-hair Brushes* are sometimes called hair pencils. These are much preferred to camel hair, and are imperative for sketching owing to their spring, thus retaining a fine point when working. Usually a set of three are employed; the large one for coarse sketches and general work, the medium and fine for the more delicate classes of work.

No. 6. *Magnifying Glass.*—Used not only for enlarging the part to be measured or examined, but principally to concentrate the vision. It is also used in conjunction with the one-hundredth part scale for measuring the size of fine whites and solids, also for examining fine work in all branches of the trade.

No. 7. *Drawing Pins.*—For securing papers in required positions.

No. 8. *Draw Point and Burnisher.*—A piece of round steel about

7 inches long, with tapered point at one end, for ruling lines on zinc plates. The other end is flattened and slightly curved for use as a burnisher in transferring impressions on zinc plates.

No. 9. *Dividers.*—Usually made of brass, about 9 inches long, and used for rough planning out.

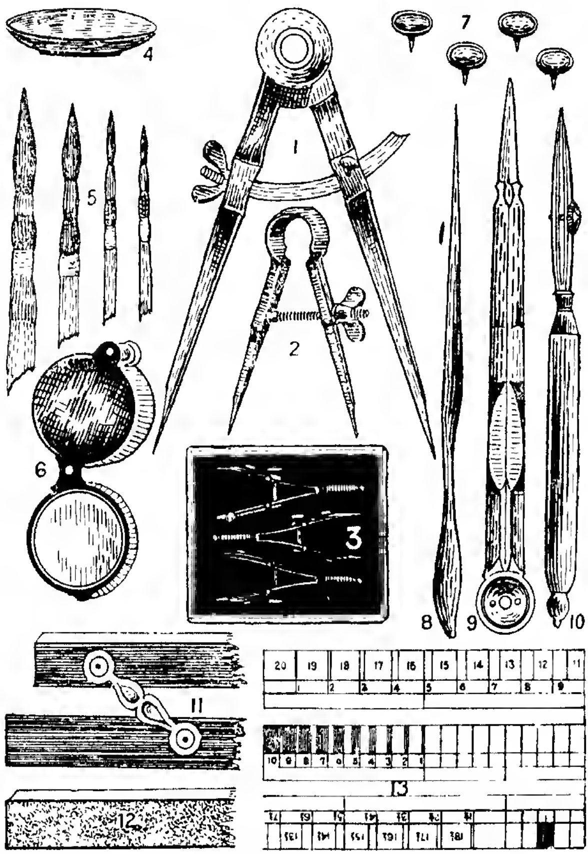

Fig 1.—Sketchmaker's Outfit.—1, Steel Compasses; 2, Steel Spring Dividers; 3, Case of Spring Bows; 4, Colour Saucer; 5, Sable-hair Brushes; 6, Magnifying Glass; 7, Drawing Pins; 8, Draw-point and Burnisher; 9, Dividers; 10, Ruling Pens; 11, Parallel Rule; 12, Steel Straight Edge; 13, 100th part inch Scale

No. 10. *Ruling Pens* with bone handle about 6 inches long. The pen inserted in this has a light spring with screw in centre to adjust the width of line required. When using this pen the bevel of the

straight edge must be next the paper to avoid it being smeared with the colour.

No. 11. *Parallel Rule.*—Principally for use on paper. They are about 9 inches long, the double piece of flat wood having a binder on angle towards each end, which allows the one piece to slide parallel with the other.

No. 12. *Steel Straight Edges* comprise a set of three. The longest is 36 inches, medium 18 inches, and a short one 9 inches long, varying in width in accordance with the length, each of them being bevelled on one edge for use with ruling pens.

No. 13. *The One-hundredth Part Inch Scale* is a small brass rule usually $2\frac{1}{2}$ inches long, and used with the aid of the magnifying glass to measure fine parts of the design. It is specially divided out to suit the requirements of the trade. Each inch is divided into 10 sections, and each section into 10 parts, thus dividing the inch into 100 parts. The tenth sections in the centre of the scale have all the lines marked off according to the number of one-hundredth parts in each section. This is mostly used for setting dividers to the required size, thus keeping the edges free from false marks. One edge has 2 inches with the number of hundredth parts marked off at each tenth, without the subdivision of lines, thus facilitating accuracy of measurement. For exceptionally fine adjustments 2 inches at the other edge are marked off in half-hundredths on the same principle.

Pencils and their Use.—For setting out plans on cartridge paper it is better to use an H. pencil, well pointed, and when drawing the line at the edge of the steel straight edge to gradually revolve the pencil. This will make the point last much longer. If a great amount of sectional ruling is required to be done the pencil should be sharpened to a flat, or chisel, point, which will retain its sharpness much longer than a round point.

For tracing on white zinc in the opaque camera, an H.B. pencil is generally used, but, should the paint be a little soft, this can be helped by using a B. pencil, in order to avoid tearing the surface of the paint.

Colouring Zinc Plates.—On the white zinc it is always advisable to touch complicated parts of the tracing with a wash or tint colour. Avoid using colour in an opaque form, as the pencil line is liable to be obliterated. Cakes of colour, 1d. each, can be obtained, and are quite suitable for the purpose required.

When the design is photographed, and the plate engraved, any parts requiring a touch of colour must be done with the opaque substance, as the tint will not show to the same advantage.

For washing tints, or opaque colouring on the plates, a camel-hair brush should be used. Although it has not the same spring as a sable hair, it suits the purpose for this kind of rough work.

Cleaning the Brush.—After a brush has been used for colouring, it should be washed by shaking it in clean water, and partially dried by drawing it across a piece of white cloth. It should then be placed on a rest so that the air can play freely around it. Brushes placed aside in a wet state soon rot and become useless, but with a little care, as mentioned, they will last for years.

Circumference of Cylinders.—The design being placed in the sketch-maker's hands, it first requires to be arranged in practical repeat form. A paper girth is supplied showing the circumference of the cylinder. On this is marked an allowance of $\frac{1}{8}$ inch for garment designs,

Fig. 2 —Garment Pattern Join Square

and $\frac{3}{16}$ inch for handkerchiefs, as an allowance for turning off the old engraving. If the cylinder has not previously been engraved, circumference alone is stated.

Enlargements.—The question of enlarging the design three or five times is then considered, and, to a great extent, decided by the nature of the work. The finer class of engraving, usually of smaller repeats, is done by five-enlargement; the coarser designs, usually large repeats, by three-enlargement.

Measuring for Repeats.—Suppose a simple garment design (see fig. 2) is received for engraving, no plan or "rough" is necessary. The sketchmaker would proceed by ruling a pencil line through the design A B as shown, and stretch the spring dividers until they embrace

one repeat; then divide across the paper girth, and either close or open out to arrange equal divisions of repeats, afterwards transferring to the zinc (which has been previously coated with white paint). Five sections would now become the repeat on the zinc.

Opaque Camera.—The opaque camera (see fig. 3), which is fitted up in a dark room, is now utilised for enlarging the pattern. The design is placed upside down in a frame at the back of the cylinder marked A. The mirror B, which is placed at an angle of 45 degrees on slide C, receives the image projected from the lens, and reflects it enlarged on to the horizontal table D. The frame on which the two cylinders rest contains the incandescent lights and reflectors E, and can be moved down to two or up to six times enlargement by turning the wheel F. The lens G is then adjusted so as to sharpen the focus. In general, photo negatives are taken without the intervention of the mirror, in contradistinction to those made by means of the mirror, which are called reverse negatives The aid of the mirror thus gives the reflection as the design and also the advantage of working on a horizontal table.

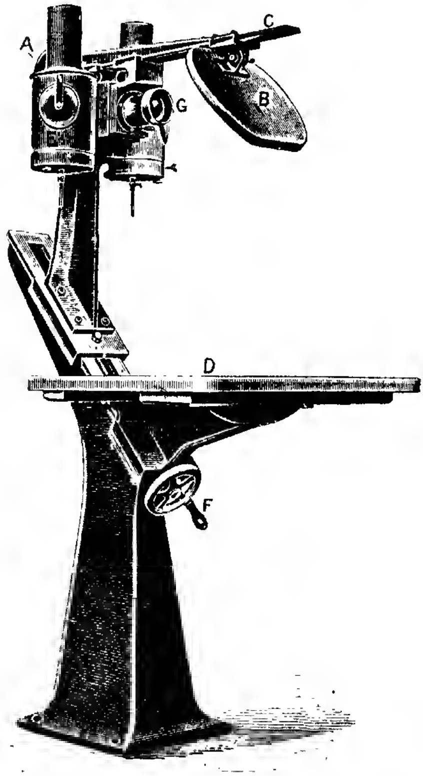

Fig 3.—Opaque Camera

Method of Tracing.—The sketchmaker now traces with a pencil on the white painted zinc the outlines of the reflected design, a section of which would appear as shown in fig. 4. For the information of the departments following, the number of the repeats which cover the circumference of the cylinder, as also the step, are marked on the top of the zinc, which is then forwarded to the plate cutter.

Sprig Design.—For a sprig design with trail (see fig. 5), a plan or "rough" is set out on transparent paper with two or more repeats ruled out for round and across. On a smaller piece of oil paper the outline of the principal sprig is traced with soft or transfer black. An impression of each repeat is then burnished with the aid of the finger nail on to the plan, and repeated. The intermediate object (if any) is traced likewise, such details as are seldom required being left to the last.

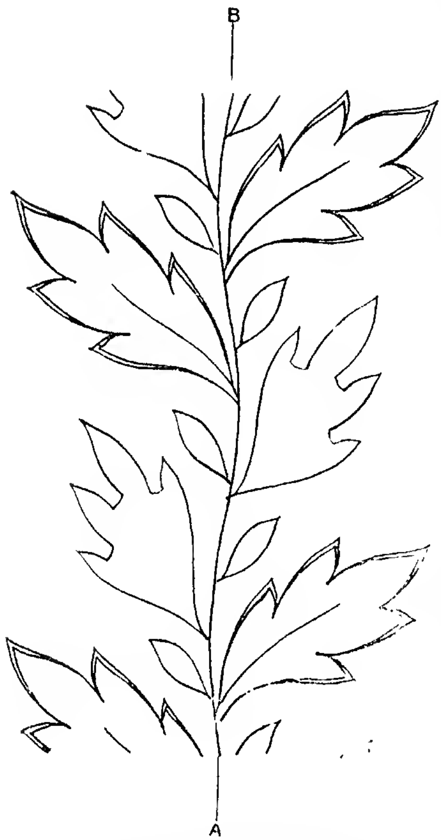

Fig 4—Diagram showing a Section of Fig 2 traced in Opaque Camera Enlarged five times

For a sprig design, as represented in fig. 6, one sprig would be drawn from the design on a small piece of transparent paper with transfer black, and transferred on the sectional or repeat lines of the plan as join square. The plan would then be turned over, and the reverse position balanced between and repeated to see that the setting was properly balanced.

Any defect can be easily rectified by cleaning out and readjusting the position of the sprig. Each different variety of sprig is traced on the zinc in the manner already described. If several of the same sprigs are required to complete the repeat, one of each variety is traced on the paper in the camera to the required enlargement, and then drawn in transfer black with the requisite allowances. If reverse positions are required, a transfer is taken from the drawings on transparent paper. Where details of design have been altered, the plan is

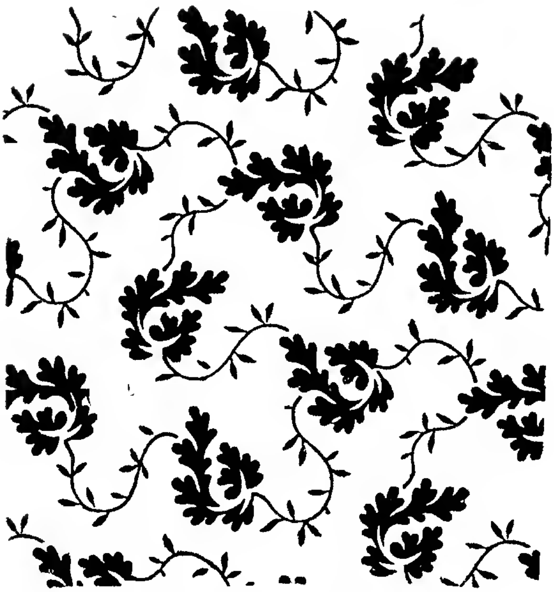

Fig 5.—Sprig Pattern with Trail, repeat half step

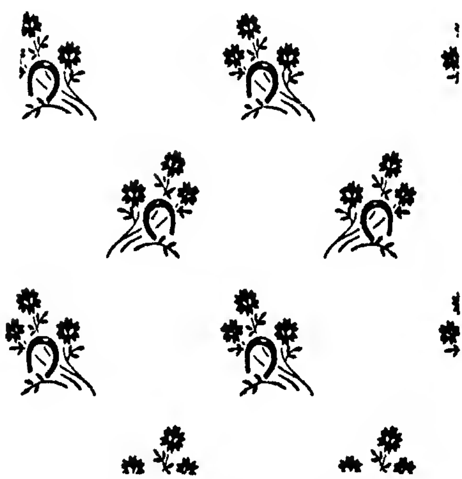

Fig. 6.—Sprig Pattern, step half and reverse.

placed in the camera and lightly traced on the zinc, then adjusted in accordance with the design. The location of sprigs is then covered over with transfer, or rosin, varnish, and the drawing adjusted and burnished, so as to give a distinct impression on the zinc.

Colour Scheme.—When a design has many colours, a touch of liquid paint conforming to each will make the sketchmaker's work more intelligible, and greatly assist the plate cutter who follows.

For all styles of garment designs that are not suitable for photography, a similar procedure is carried out.

Points to be observed.—In connection with sketchmaking there are several points which require special care in the initiatory stages of apprenticeship. The first essential is exactitude, both in "raising" squares and also ruling repeat and sectional lines, either on paper or zinc plates. If this habit is well grounded at first it becomes second nature, and constitutes reliability which quickly becomes noted with this class of workmanship. This is also the foundation for securing good joinings in the Pentagraph machine, which, with certain classes of work, is imperative.

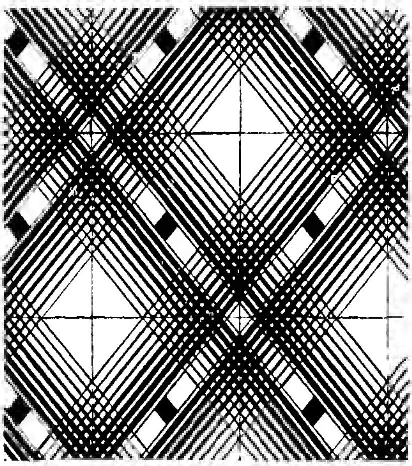

Fig 7 —Pattern showing Diagonal Check which should be set out on Plate. Join square

For a simple check design, such as illustrated in fig. 7, it is important that the joinings of the lines at the repeats, both on the side and bottom, should be perfect, otherwise no end of trouble will ensue. It is also advisable that such patterns should be set out on the zinc for working join square (unless the repeat is exceptionally large)—*i.e.*, should the repeat on the pattern show a half step, as in fig. 6, it is more economical in the long run to give the two half sketches, and repeat the plate as a join square, so as to obviate the many difficulties which the pentagrapher would be certain to encounter with the half step.

Shape of Leaves.—Previous to starting a tracing in the opaque camera, the design should be studied, and any special feature

carefully noted, such as form and construction of leaves, as shown in fig. 8, which it will be noted have a peculiar drooping plumpness towards the point. In tracing these in a careless and too pointed a

Fig. 8.—Showing Sprig with Plump Leaves.

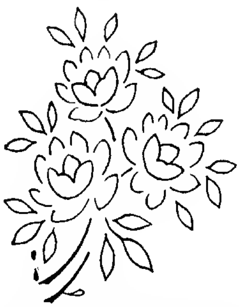

Fig. 9.—Showing Fig. 8 enlarged and traced in a too careless and pointed a manner.

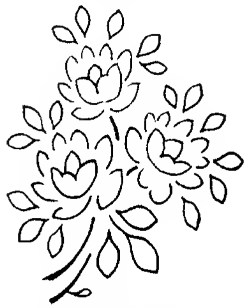

Fig. 10.—Showing Fig. 8 enlarged and traced correctly.

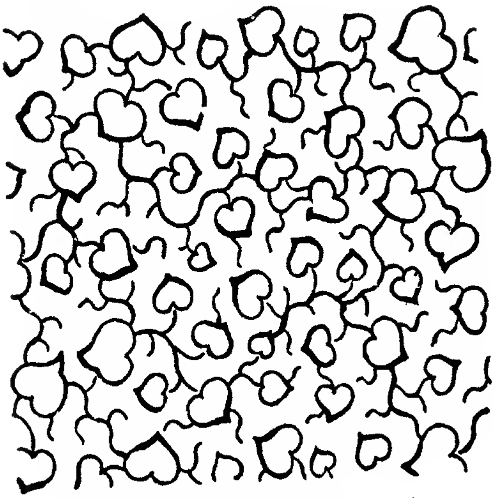

Fig. 11.—Pattern where the Law of Growth has not been properly sustained.

Fig. 12.—Sprig with Plump Rosettes.

manner, when enlarged (as shown in fig. 9) the character of the design may easily be lost. By reference to fig. 10, the correct form will be observed, and contrast noted. Further, with leaves or stems of a trailing nature, the character of a design may be marred by failing to sustain the law of growth (as shown in fig. 11).

Rosettes.—Again, with rosettes, as shown in fig. 12, the young apprentice is very apt to give the wrong set of the "lobes" by tracing them, as shown in fig. 13, and to make the points too open at

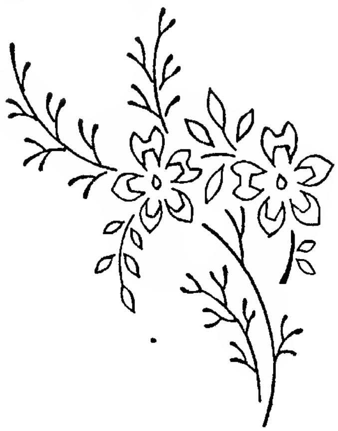

Fig. 13.—Showing Fig 12 enlarged with Wrong "Set" of Lobes on Rosettes

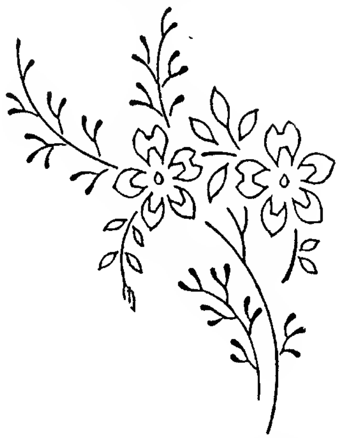

Fig 14.—Showing Fig 12 enlarged with Correct "Set" of Lobes on Rosettes.

the indents, instead of keeping them on the close side, as shown in fig. 14. When tracing floral designs formality and stiffness ought to be avoided; a sweetness should be given to the work by adopting a style of ease with graceful flowing lines, ever remembering that although the floral design is conventionalised to suit the requirements of the trade, the natural representation must not be lost sight of.

Fig. 15.—Sprig built up with Chene Points

Chene Work.—When building up shapes with Chene work (see fig. 15), it is always advisable to run a continuation of the point right through the small solids, and cut up the intersections with a line between, as shown in fig. 16. This gives quite a solid effect without showing the harshness which would undoubtedly appear if the shape was outlined and grounded, as illustrated in fig. 17. When Chene points require to be tapered off from large solids, it is always well to guard against tracing the indents too open, as it leaves the edge of the solid too harshly defined, although it may be irregular.

These are points worthy of consideration and adoption if the prettiest and softest results are desired in the finer class of Chene designs.

The tracing of the points to define the edge of mid effects secured by shades of the dark colour falling on the pale, can also be better sustained if the sketchmaker avoids having them traced in too pointed

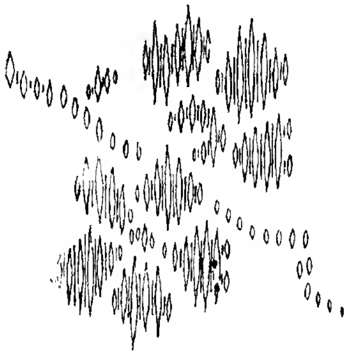

Fig 16.—Sprig (fig 15) enlarged with Points traced right through

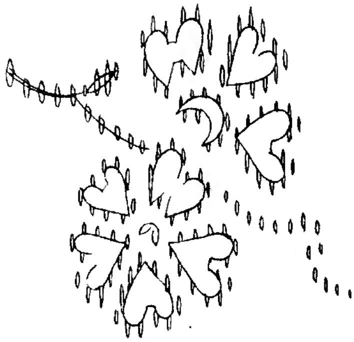

Fig 17.—Shapes defined with Solid Edge.

a manner (as shown in fig. 18), but runs the point in a little quicker towards the finish, and allows a very short line to be cut by the plate cutter at the point, as shown in fig. 19.

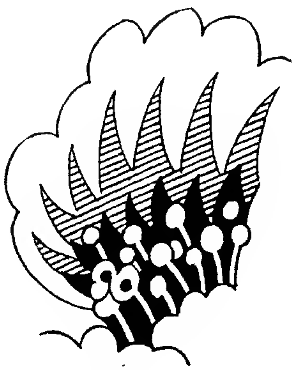

Fig. 18.—Showing how Points should not be traced

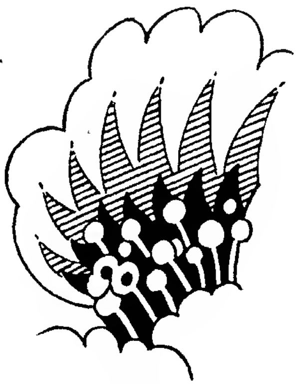

Fig. 19.—Showing how Points should be traced.

Cashmere Work.—The name Cashmere was originally given to a fine class of fabric made in India from the hair of the Cashmere goat. The once much prized Paisley shawls had beautiful illustrations

of this peculiar detail work arranged in most of their elaborate pine designs, and from them it seems to have been introduced into calico. To imitate this class of work correctly (as shown enlarged in fig. 20), it would entail too much labour in forming the white veins, and ground-

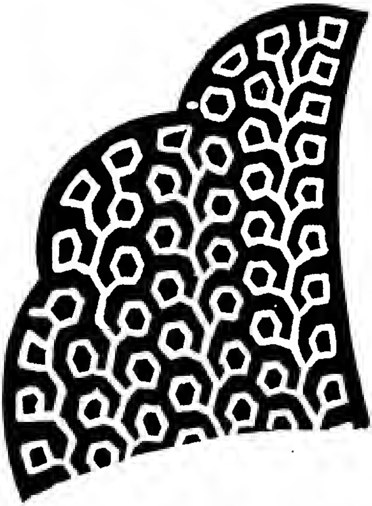

Fig. 20.—Showing Correct Form of Cashmere Work.

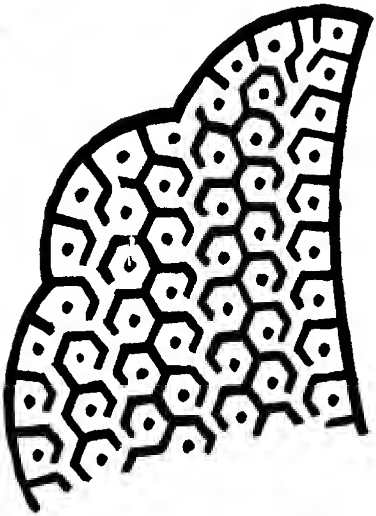

Fig. 21.—Showing how Engravers arrange Cashmere Work.

ing out the square eyes. A simpler method in imitation of this effect is adopted for calico in a somewhat reverse manner, by forming a line for the solid, and placing in a spot for the eye (as shown in fig. 21). To cover large spaces with this work there is an art in planning it to show to the best advantage. The double line to form the white vein should always be arranged, except when coming into corners, where space will not admit of this.

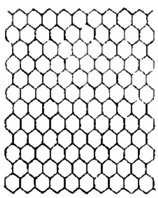

Fig. 22.—Regular Honeycomb, skeleton effect.

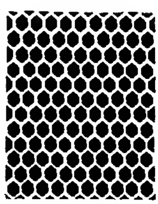

Fig. 23.—Regular Honeycomb, solid effect.

Honeycombs.—This well-known shape may be divided into two classes, Regular and Promiscuous. Each may be arranged to show a skeleton or solid effect, and of various scales as required. Fig. 22 shows the regular skeleton form

which is a perfect hexagon. Fig. 23 shows the same form, but as a solid with the white vein outstanding. The promiscuous form, as illustrated in fig. 24, has, it will be observed, the six-sided figure as a base, with five- or seven-sided figures interspersed to procure the

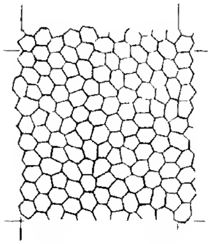

Fig 24.—Promiscuous Honeycomb, skeleton effect

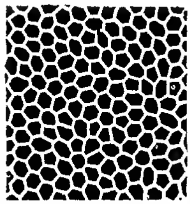

Fig 25.—Promiscuous Honeycomb, solid effect

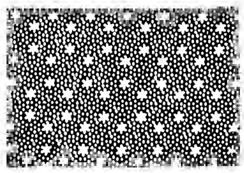

Fig 26.—Honeycomb formed from the Seven Pin, with pattern introduced

desired irregularity, from which it is named the promiscuous honeycomb. Fig. 25, again, shows it as a solid effect. There is another form of honeycomb arranged from the well-known seven pin (as shown in fig. 26). This honeycomb is principally used by the diemaker to form small patterns as shown on the same figure.

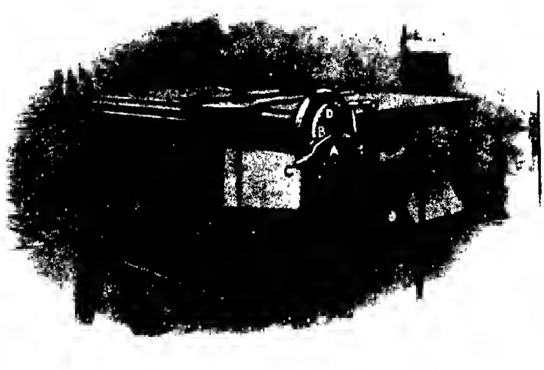

Fig 27.—Ruling Machine for Plates

Ruling Machine (see fig. 27).—This is a simple yet useful machine where a series of parallel lines require to be ruled out on the zinc. For a design, such as illustrated on fig. 7, the ruling machine would

prove an ideal medium for obtaining the exactitude required. Or if it was thought advisable to open out or close the scale of lines, a reference would be made to the "shade scale" (as shown in fig. 28), and the number of lines to the inch fixed accordingly.

The wheel marked A, which is fixed to the screw, has 90 teeth, and moves the trammel ¼ inch for each turn. A reference to the gear table is made, and the required number of teeth set by lifting the small clutch B, which is attached to the handle C, and screwing the bolt D against the handle.

The plate is now laid on the table, and the ruling point E set to the required angle by moving it along the trammel F to the opposite end of the plate. When adjusted, several small tacks are placed through the plate for security. It sometimes occurs that a certain

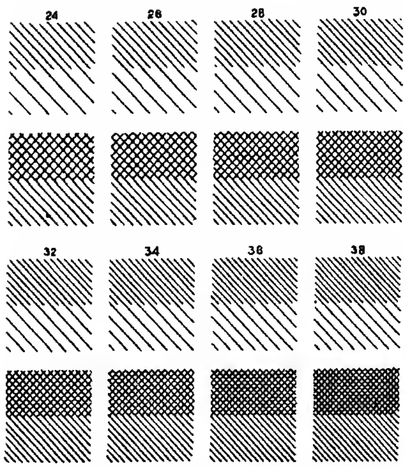

Fig 28.—Reference Table for Scale of Shade Lines.

Fig 29.—Cutting Point for Sketchmaker's Ruling Machine.

number of lines are required to join at the repeat. These divisions should be marked and the travel of the machine tried across and the bolt D adjusted as required. It is sometimes advisable to alter the repeat after such lines are ruled, rather than to try to force the machine, and thereby give irregular lines. When working the machine it is imperative that the handle should always be struck against the bolt in a regular and gentle manner, because if struck heavily and lightly in a careless fashion irregular spaces are sure to be produced. The ruling point should be prepared (as shown in fig. 29), and when drawing

the tool (always towards you) only a medium depth of line requires to be cut, and, as near as possible, to the depth of engraving for plate cutting.

GEAR TABLE FOR RULING MACHINE.

Number of lines to the inch.	No. of teeth on wheel for five enlargement.	No. of teeth on wheel for three enlargement.	Number of lines to the inch.	No. of teeth on wheel for five enlargement.	No. of teeth on wheel for three enlargement.
20	90	54	44	41	24
22	82	48	46	39	23
24	75	45	48	37	22
26	69	42	50	36	21
28	64	38	55	33	19
30	60	36	60	30	18
32	56	33	65	28	16
34	53	31	70	25	15
36	50	30	75	24	14
38	47	28	80	22	13
40	45	27	85	21	12
42	43	25	90	20	11

Fractions are omitted in the calculations

Settings for Garment Designs.—The variety of settings for garment designs is legion, and for convenience the sketchmaker keeps a stock of different pin settings, or plans, arranged on a reduced scale, whereby the most suitable can be at once selected, according to the nature of the design.

Join Square.—The simple join square (see fig. 2) is a pattern repeating itself on the same level across.

Half Step.—A half-step pattern (see fig. 5) is one which drops half the depth of the repeat. It should be noted that if a pattern is designed on square lines, and is turned one-fourth round to make it repeat as a half step, the measurement of the repeat is entirely different, being thus made equal to 7 inches as against 5 inches on the square.

Half Step and Reverse.—If a pattern is arranged with a sprig half step and reverse (see fig. 6), the sprig drops half the depth of the repeat, and is then reversed. If the setting is not too close, one sprig can be placed on the plate and reversed in the machine. If very close set, it is advisable to place it right and left on the plate, and mark it for working as join square.

Odd Steps.—There are many varieties of designs which repeat better at one-third continuous or back. When continuous (see fig. 30), every fourth repeat is square ; when one-third and back, every second

repeat is square. The design may be repeated any distance less than one-third, but when the repeat is less, care must be exercised, since the recurrence of any marked or prominent feature in the design has a greater tendency to stripe. The latter defect must always be guarded against in promiscuous settings, because of the monotonous effect produced by running in regular lines and angles. In fig. 30, the design is arranged in perfectly regular lines, yet no defect is noticeable, because of the pleasing effect and variety obtained by the "tossing" of the sprigs.

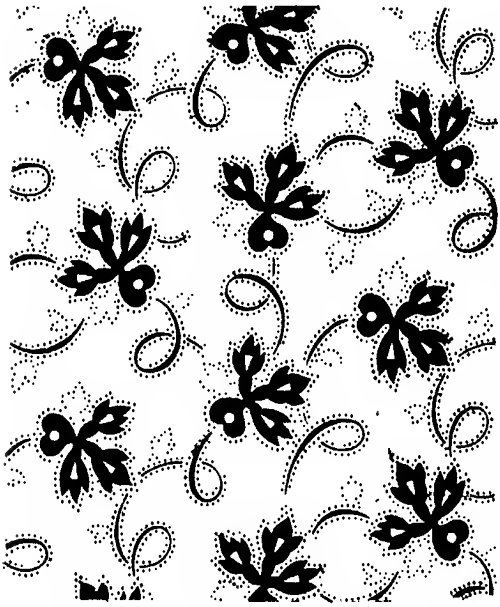

Fig 30.—Sprig Pattern with Trail. Step one-third continued.

Three Sprigs on Angle.—Certain designs can best be arranged as three on angle (see fig. 31). This repeat, it will be noticed, steps one-fifth on—*i.e.*, the fifth step

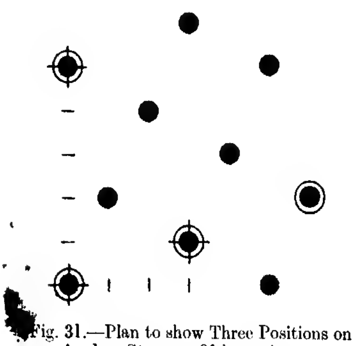

Fig. 31.—Plan to show Three Positions on Angle. Step one-fifth continuous.

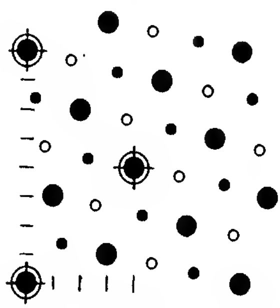

Fig. 32.—Plan for Four Positions on Angle. Step half.

would be continued, and every sixth section would join square. This setting is obtained with five divisions in the round, and three across. The sprigs are equidistant only on the angles, thus showing the acute and obtuse angles very pronounced. This arrangement is most suit-

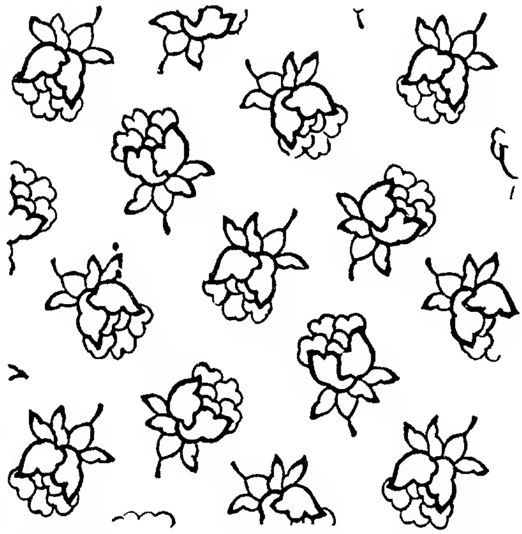

Fig 33.—Pattern arranged for Four Heads on Angle Step half.

able for three different sprigs, where one of each is required in the sketch. When repeated it shows the formation of the square on angle very prominently.

Four on Angle.—Some designs, with four sprigs, may be arranged four on angle (see fig. 32). This method is employed where small objects are placed on the hexagonal form around the principal sprigs. The arrangement shows the formation of the diamond in acute and obtuse angles, or heads alone, as shown in fig. 33.

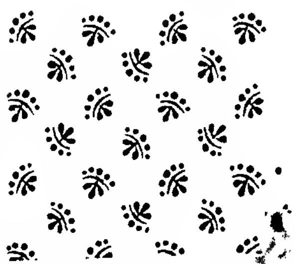

Fig. 34.—Pattern showing Four Positions. Step half.

The acute and obtuse angles can be avoided if required, and a pattern set out with four positions on formal lines and half stepped, as shown in fig. 34. Or join square, as in fig. 35.

Five on Angle (see fig. 36).—The five on angle is very similar to

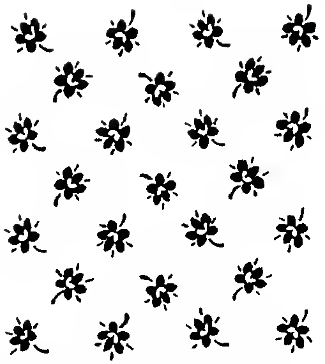

Fig. 35.—Pattern showing Four Positions. Join square.

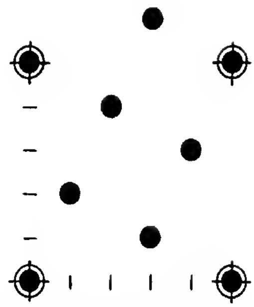

Fig. 36.—Plan for Five Positions on Angle. Join squares

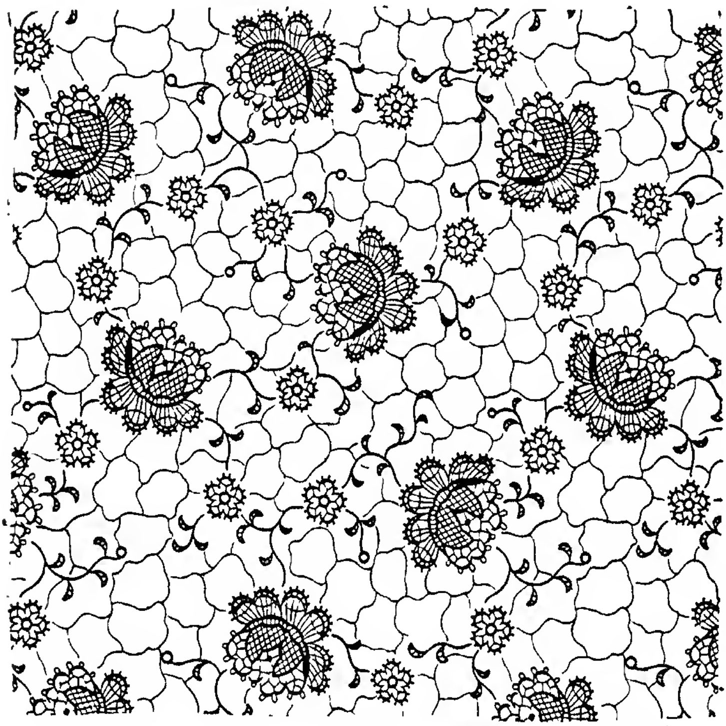

Fig 37.—Pattern arranged with Heads as Five on Angle. Join square.

the three (see fig. 31), and where the arrangement is rather close in repeat for the pentagraph machine, and the variety of colouring in the sprigs of little consequence, it is better to adopt the five—in preference to the three—arrangement, as offering an opener set and a square joining for the repeat. Fig. 37 shows a pattern arranged five on angle, join square.

Seven on Angle.—Mention should also be made of the seven on angle setting, which is obtained by adjusting the circle pens, or dividers, to half the radii required, and describing a circle, then placing the point on any part of the circle, making another circle, and so on at each intersection (see fig. 38), each unit having seven objects (tossed about) in the repeat, half stepped (see fig. 39). Here the repeat may be arranged in two ways, either with a long repeat

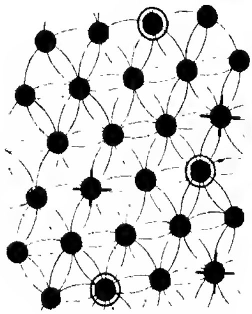

Fig. 38.—Plan for Seven Sprigs on Angle Half step.

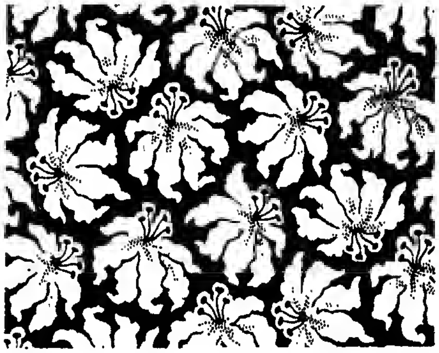

Fig. 39.—Pattern built on Plan 38, seven sprigs in repeat Half step.

in the circumference (see double rings in fig. 38), or *vice versâ* (see crosses in same figure).

Four Diamond Setting.—In more promiscuous arrangements the simplest form is certainly the four setting, sometimes called the diamond plan (see fig. 40), owing to the prominent feature being the diamond shape, alternately perpendicular and across. Here the repeat is obtained from 11 divisions across, and 22 in the round, repeat steps one-half. A simple two-colour pattern can be arranged from this method of procedure (see fig. 41), having the one colour with two sprigs across, and the other colour with two in the circumference. Fig. 42 shows a leaf set out on this four arrangement, join square. It can also be turned on angle, thus obviating any formality

which the method illustrated in fig. 41 might have a tendency to reveal, and at the same time giving greater adaptability to the circumference of the cylinder. Good arrangements may also be secured from this setting for large sprigs with sprays and spots trailing between, as in fig. 43.

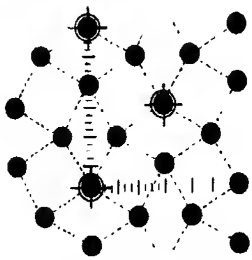

Fig 40 —Diamond Plan, four setting. Half step

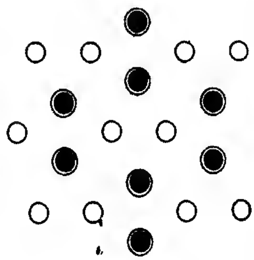

Fig 41 – Diamond Plan for Four Setting Two colour, half step.

Five Setting.—The five, or pentagonal, arrangement is simple (see fig. 44) yet very effective for distributing small sprigs around the larger one. The repeat here is half stepped, and is obtained with 14 divisions across, and 16 in the round.

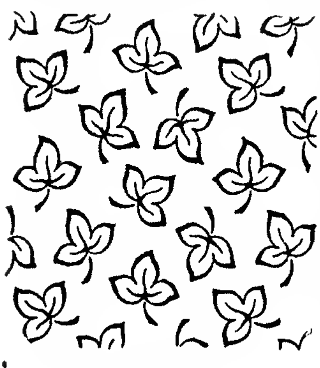

Fig 42 —Pattern set on Diamond Plan. Join square

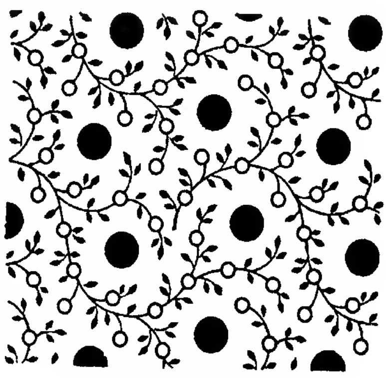

Fig. 43.—Pattern with Spray set on Diamond Plan on Angle. Join square.

Six Setting.—In the six arrangement (see fig. 45), which can be set out with 24 divisions across and 24 divisions in the round, the geometrical planning which can be secured is most striking. The eye is at once attracted by the hexagonal shape, while inside the hexagon four pentagonal shapes are formed, and each of these again may be subdivided into three triangles.

The floral design is best set out by forming the square according to the repeat in the circumference of the cylinder, bisecting this repeat

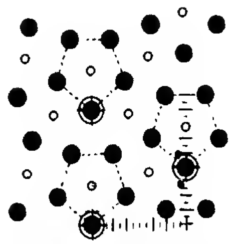

Fig 44.—Plan for Five Setting, showing pentagonal form. Step half

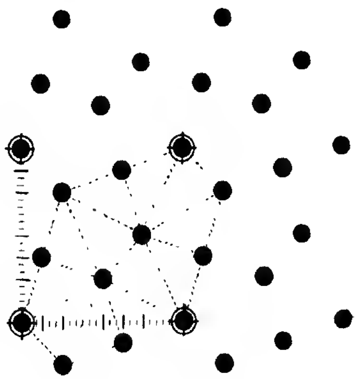

Fig 45.—Plan for Six Objects Join square.

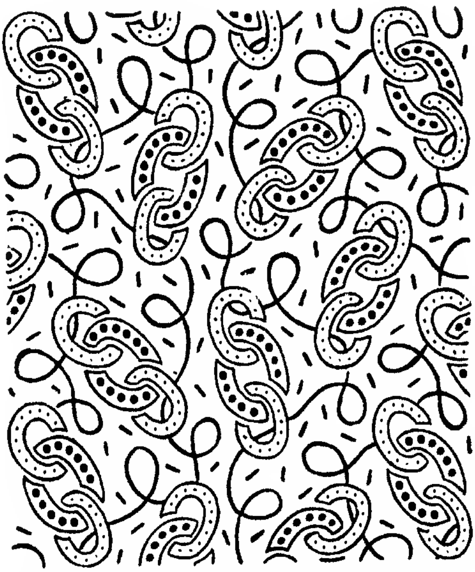

Fig. 46.—Pattern showing the Six Setting. Three objects join square, and reversed under

on the perpendicular and also on the cross, and repeating the flowers on the four intersections. The diamond shape on angle is then formed

with the other four positions—*i.e.*, six join square. For economy in sketchmaking and zinc cutting, half the repeat can be arranged—*i.e.*, three objects (fig. 46). These are reversed in machine to complete sketch.

Again, the six can be worked in harmony with the four-pin half step (fig. 47). This also gives a good two-colour arrangement, as, for instance, the large shaded object set on the four in one colour, and the skeleton, set on the six, in another colour.

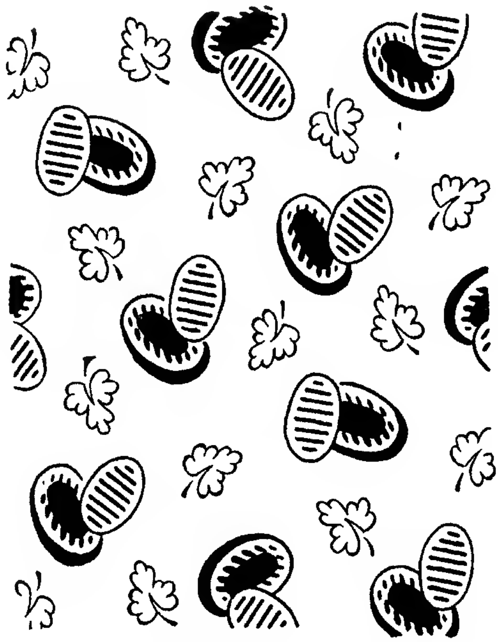

Fig 47 -Pattern illustrating the Six and Four Settings, working together

Seven Pin.—The seven-pin arrangement is the most useful in practice, not only for its simplicity of setting, but also from the variety of methods of application. It also forms the basis of the nine-, eleven-, thirteen-, fifteen-, sixteen-, twenty-two-, and thirty-pin settings. The method of procedure in setting out is, first, to raise a square; then, with the dividers set half the distance from object to object, a circle is described intersecting the lines of the square (see fig. 48). The circle is then divided into six equal parts and a line drawn through each intersection, thus forming a hexagon. The

design is then repeated equidistant in the circumference, and half stepped in the width, thus securing uniform arrangement of objects.

It may also be arranged with a series of 19 divisions across and 22 divisions in the round, as in fig. 49. If unsuitable for the circum-

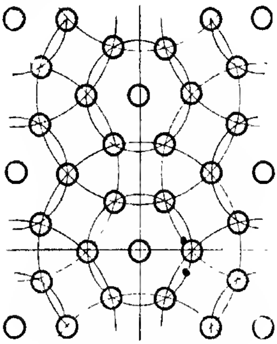

Fig. 48.—Plan showing the Seven Setting arranged from Circles.

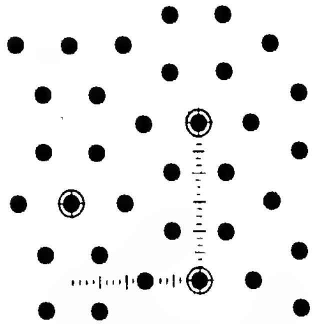

Fig. 49.—Plan showing the Seven Setting arranged from Divisions.

ference of the pattern, it may, further, be turned one-quarter, thus giving the long repeat in the circumference and the narrow repeat across.

The geometrical formation of this setting is very unique and decided. Observe in fig. 48 the series of circles that intersect all the

Fig. 50.—Pattern (white ground) set on the Seven Pin. Half step.

spots, as well as the various angles radiating from the centre between the spots, and also the angles occurring between the spots. In this way is obtained the seed shape from sections of the circles. Fig. 50

shows a white ground pattern, and fig. 51 a blotch ground set on the seven-pin arrangement. A further use of this universal setting,

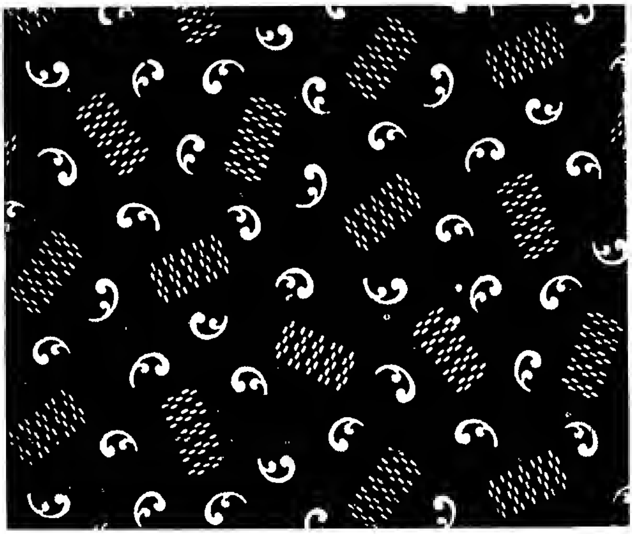

Fig 51 —Pattern (blotch) set on the Seven Pin Half step

which must not be lost sight of, is its suitability for trail arrangements, as shown in figs. 52 and 53.

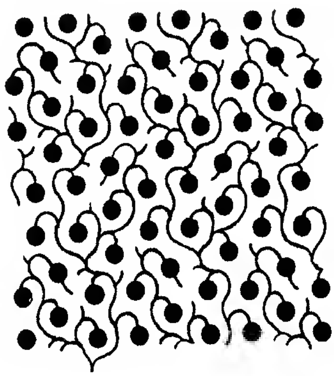

Fig. 52 —Pattern showing a Close Trail arranged on the Seven Setting Join square.

Nine Setting.—The nine-pin arrangement, as before indicated, has the seven as its basis. It is repeated, as shown in fig. 54, half stepped.

This allows the two spots between the seven to form a diamond shape. Finally, the repeat is secured by 15 divisions across and 36 in the circumference.

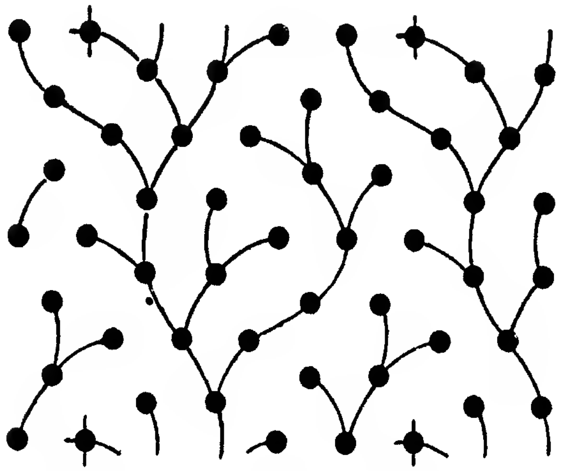

Fig. 53.—Pattern showing an Open Trail arranged on the Seven Setting. Join square.

Eleven Setting.—The eleven pin has also the seven as its basis, the distinguishing feature being the four pin between the seven, which forms the diamond, around and across (see fig. 55). It must

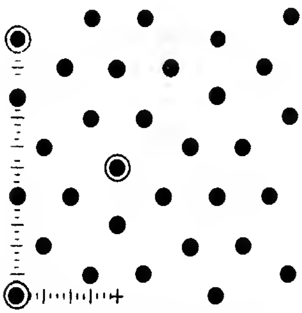

Fig. 54.—Plan to illustrate the Nine Setting Half step.

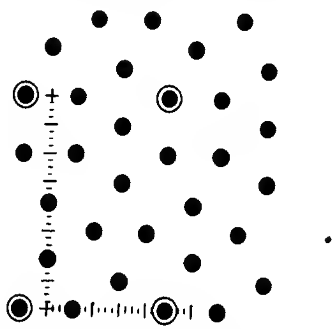

Fig. 55.—Plan to illustrate the Eleven Setting. Join square.

join square, and to find the repeat there are 22 divisions across and 30 in the circumference.

shows a white ground pattern, and fig. 51 a blotch ground set on the seven-pin arrangement. A further use of this universal setting,

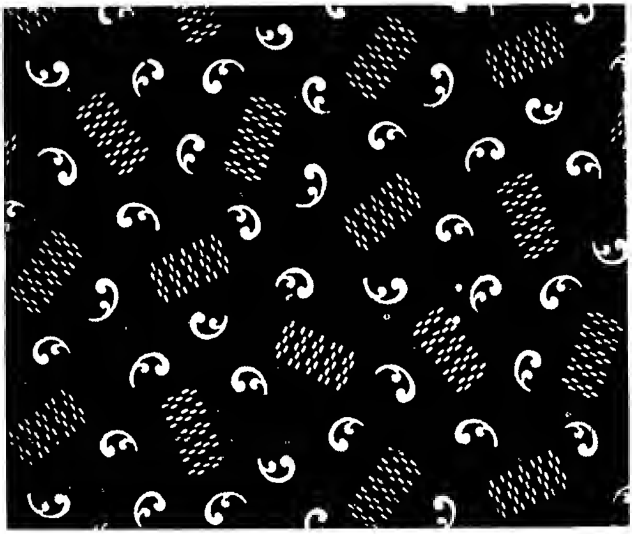

Fig. 51.—Pattern (blotch) set on the Seven Pin. Half step.

which must not be lost sight of, is its suitability for trail arrangements, as shown in figs. 52 and 53.

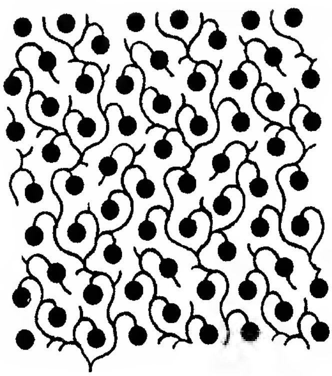

Fig. 52.—Pattern showing a Close Trail arranged on the Seven Setting. Join square.

Nine Setting.—The nine-pin arrangement, as before indicated, has the seven as its basis. It is repeated, as shown in fig. 54, half stepped.

and the solid spots show on angle the four-diamond plan, already described in fig. 40. The cross hatching indicates the third colour, and the single rings form the fourth. Third, there is the formal arrangement illustrated in fig. 61, as three colour. Here the repeat is in half steps with 16 divisions across and 32 in the circumference

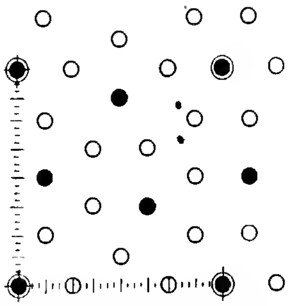

Fig. 58.—Plan to illustrate the Fifteen Setting. Join square.

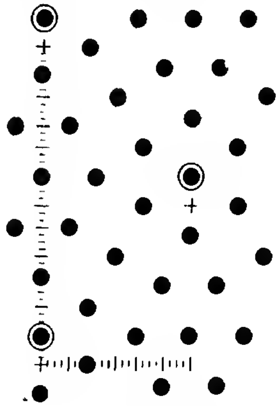

Fig. 59.—Plan to illustrate the Sixteen Setting. Half step.

Twenty-two Setting.—The twenty-two pin has its base from the seven, perpendicular and across (see fig. 62), the remaining eight

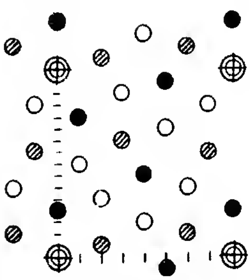

Fig. 60.—Plan to illustrate the Sixteen Setting, four colours. Join square.

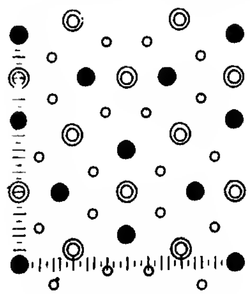

Fig. 61.—Plan to illustrate the Sixteen Setting, three colours. Half step.

pins forming two diamonds between the sevens. It is arranged with 30 divisions across and 44 in the circumference, and follows after the style of the sixteen setting.

Thirty Setting.—A useful arrangement is the thirty pin, and one seldom used to the extent its utility would warrant (see fig. 63). It is produced from 22 divisions across and 44 in the circumference, and the step is half. It has the seven as its base, perpendicular and across. The two spots between each seven in the round equal four, and the six between the sevens across equal twelve, thus completing thirty in the sketch. It will be observed that the well-known four forming the diamond can also be arranged; see large rings in same figure.

After a study of the foregoing pin arrangements it will be seen that they are all based on geometrical principles. The very nomenclature implies as much. They might, in fact, be termed mere scaffolding for floral designs; but when once the student has acquired the knowledge of these various pin settings, and can arrange flowers "tossed" on these, the formality disappears.

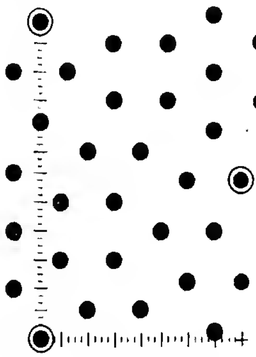

Fig 62.—Plan to illustrate the Twenty-two Setting Half step

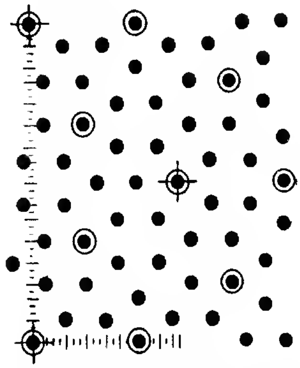

Fig 63.—Plan to illustrate the Thirty Setting, with the four diamond pin Half step

Simple Settings of Sprigs.—For simple settings of flower sprigs there are other methods of giving variety without resorting to the pin arrangements. A very beautiful and simple method is the two-and-two row, or French mix (see fig. 64). Here the sprig is half stepped, forming two rows; then reversed and repeated similarly for two rows. The repeat for the circumference of the cylinder must embrace the four rows if the repeat is small, or two rows and reverse in machine if the repeat is of a larger nature.

The same pattern might be arranged with three positions in the circumference (fig. 65), and repeated half step in the next row, which would give a long repeat in the circumference and a narrow repeat across.

Again, a choice is afforded by repeating the flower underneath the original (fig. 66), and with the further variety of three positions in the width, half step.

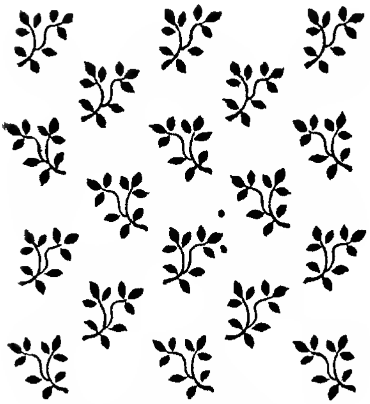

Fig 64.—Pattern showing the Two-and-two Row, or French Mix

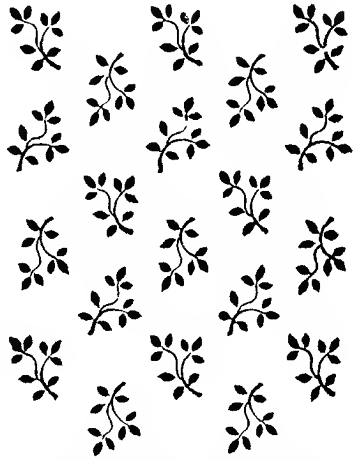

Fig 65.—Same Pattern as Fig 64 arranged with Three Positions in Circumference Half step

This chapter has been purposely treated, for the most part, with skeleton plans, because the various settings offer particular lines of

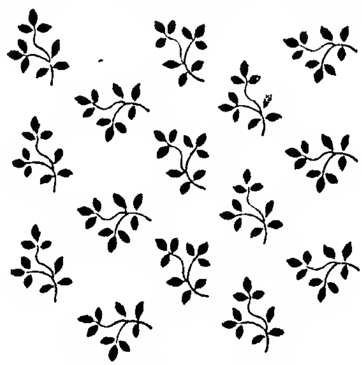

Fig. 66.—Same Pattern as Figs. 64 and 65 arranged with Three Positions in Width. Half step.

construction; it is, therefore, worth the sketchmaker's while to well consider the various plans upon which garment designs can be arranged.

CHAPTER IV.

PHOTOGRAPHY AS APPLIED TO CALICO ENGRAVING.

The Enlarging Camera.—The sytem of photography suitable for calico-engraving purposes requires an enlarging camera (see fig. 67), which is used to project an image of the copy from the light studio A into the dark room B.

The design is set up on a travelling easel C in the light room; the optical arrangement is mounted with convenient adjustments in an aperture in the dividing wall D between the light and dark room. The enlarged image is projected on to another travelling easel E in

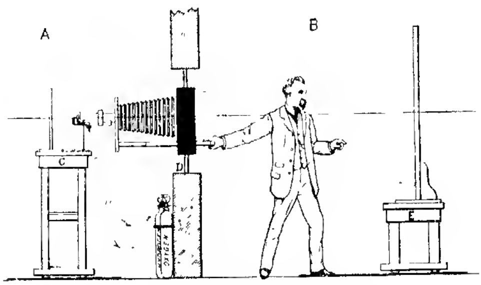

Fig 67.—Photo Enlarging Camera

the dark room, on which the zinc for the enlargement is placed, so that it can be photographed or traced if desired.

Systems of Wet-plate Photography.—The older system of wet-plate photography had many difficulties, especially with the silver bath. The newer system of prepared emulsion overcomes these to a great extent, and saves a vast amount of time. This method of photography is not required as a permanency, but only as a means to an end. Any defects therefrom, such as spots, stains, or slight halation, are not reckoned as serious blemishes.

Setting Out Design.—The design is "set out" with pencil lines to show the repeat and joinings. It is advisable also to consider the nature of the colours, because sometimes a pencil or white line

is required between them, as in the case of black and red coming together.

Photography for Pentagraph Work.—For pentagraph work the surface of the zinc plate would be previously blackened, and cut to the required dimensions, $\frac{1}{4}$ inch of the edge is then turned up all round to form a tray for developing (thus dispensing with the old system of the glass), and photographing direct on to the zinc.

Adjusting the Easel and Lens.—The design is fixed on the board of the easel in the light room, and the ground glass on the easel in the dark room. The easel in the dark room is moved backward or forward as desired, although it is convenient to have marks on the floor of the room for the three and five enlargement. The lens is then adjusted to sharpen the focus, and the aperture of the lens fixed according to the amount of detail in the design, remembering that, as in ordinary photography, the plates are sensitive chiefly to the blues and violets; therefore, if these colours predominate in the design, a shorter exposure will be necessary.

Emulsion.—The next operation, that of flooding the zinc plate in a horizontal manner with emulsion, must be performed in a ruby light only. The emulsion may be drained off into a separate vessel, and it is quite good for after use on work of less importance. In about two minutes the emulsion will have set sufficient to allow the plate to be flooded with the sensitizer. The plate is now fixed on a board with four tacks, and placed where the ground glass was. The cap is now taken off the lens and replaced when sufficient exposure has been given. The plate is then lifted from the board and washed under the water tap for two or three minutes to take away any grease from the surface.

Developing.—The developer must be poured over the plate with a quick motion to give an equal wave. Any hesitation at this point will result in a mark across the plate. At the same time, care must be taken to spill as little as possible into the sink, or else the image will be thin, on account of the absence of free silver washed off by the wave of the developer.

Rock the plate gently so as to keep the developer flowing to and fro. The image will soon appear, faint at first, but gradually growing darker, the black parts showing white and the white parts black. When the design appears sufficiently strong, pour developer into a separate bottle for after use, and wash the plate sufficiently under the water tap, which is shown by the water flowing evenly, without leaving greasy-looking lines.

Fixing.—Drain the plate a little and get ready for fixing, which is done by pouring hyposulphite of soda over it and rocking the plate

backward and forward for about 10 minutes. The plate is next washed in running water for about 10 minutes, drained, and allowed to dry, which process can be hastened a little, if required, by the use of a gentle heat. The repeat lines are then ruled out on the zinc and joinings rubbed down where essential.

Photography for Hand Engraving.—This requires to be done in *a different manner from the method already* explained for the pentagraph. The repeat lines are drawn with pencil on the design, and a white or soft pencil line placed between colours that would show equal value in tone on the negative. The easel in the dark room is set close to the lens and adjusted to the size required, while the shadow of the design is focussed on the ground glass, as already explained.

Instead of the zinc a piece of good flat glass is used, and treated in the same manner for all the processes up to the drying of the glass plate. A piece of cartridge paper is then cut the size of the glass, and spread over with good clean gum and squeegeed down on the glass. The glass plate is again dried and a knife run over the surface all round near the edges of the glass, a corner lifted up and the paper pulled off, which should lift the film quite clean from the glass. Previous to stripping the film the roller should have been set out, and the required part covered with Bates' photo black. The setting-out lines are now traced through the black, which will serve as a guide when placing the photo on to the surface of the roller. A pitch is cut on the photo, and tried on the roller to see that all is in order; the blackened part of the roller is now covered with rosin varnish or gum, and the photo, with the film side lowermost, laid on the roller according to the pitches and squeegeed all over. When dry, a clean sponge is dipped in water and the paper moistened, but not overdone. The edge of the paper is raised a little and then pulled off in one sweep. The surface of the film is lightly washed with a sponge and water, when a clean white film showing all details of the design in various tones should be the result. After lying for two or three hours to dry it is ready for the hand engraver, who will find that when cutting through a photo film the engraving requires to be very slightly stronger, owing to the coating of the black and the film tending to create a deception as to the strength of the engraved line.

On this photo part the leading colour is engraved the required strength, and, if thought advisable, all the other colours hair lined. When completed the film is washed off with caustic soda or paraffin, and impressions taken from this part and repeated on the rollers, as explained under hand engraving.

Chemicals.—The chemicals used for this method of photography are simple.

Emulsion.—This is known as Dr. Albert's "Eos" emulsion for line work. Before using, it must be thoroughly shaken in a partially filled bottle for two or three minutes to redissolve any precipitate of bromide of silver which settles at the bottom of the bottle. It is also advisable to keep it in a cool place, as the emulsion works better when below 60° F. A high temperature tends to produce fogging.

Sensitizer.—The A sensitizer is best, and is made up as follows:—One part sensitizer to 10 parts of pure alcohol.

Developer.—It is known as the hydroquinone developer; a concentrated solution is made up as follows:—

A.—Distilled water,	20	ozs.
Sulphite of soda,	10	,,
Carbonate of potash,	8	,,
B.—Hydroquinone,	1	,,
Distilled water,	4	,,
C.—Ammonium bromide,	1	,,
Distilled water,	4	,,

Mix in above order and label bottle "Stock Solution." It will keep several weeks. For use in developing add 3 ozs. of stock solution to 20 ozs. of water. All these chemicals must be kept and also worked in the dark.

Lenses.—Practically all lenses are of equal rapidity if used at the same aperture in proportion to their focus, and with the same degree of enlargement or reduction—*i.e.*, if we copy the same size with any lens, the exposure will be practically the same if the stop is of the same focal value, but note that prisms and colour filters make a difference.

A cheap single lens may be dear at any price by giving distorted photographs. They lack definition towards the edges, and also cause irregular movements of the rays of light as they pass through. They may cause two defects:—First, Spherical aberration, arising from rays of light passing through different parts of the glass and focussing at different points. Second, Chromatic aberration, which proceeds from the different rays of which light is composed, as, for instance, yellow and blue, being bent to different extents in passing through the lens, and, therefore, focussing at different points.

The single lens with the stop in front produces barrel-shaped distortions; the same lens turned round and the stop placed behind

reverses the distortion. A combination of the two lenses produces what is now known as the rapid rectilinear variety (see fig. 68) with a lens before and behind and the stop between. This type of lens holds its own for all-round photography, and only costs a fraction of that of the more recent introduction, which certainly avoids all chance of astigmatism, the lens being made of crown and flint glass, and known as the anastigmatic lens.

Stops.—The marking of stops with such symbols as F/8 means that the stop has a diameter equal to one-eighth of its equivalent focus. If F/8 stop requires one minute exposure, F/11 will require two, F/16 four, F/22 eight, F/32 sixteen, F/45 thirty-two, and so on, each smaller stop requiring double the exposure of the preceding one if the same extension of the camera is maintained.

Camera Extension.—In altering the extension of the camera it should be noted that the exposure will increase as the camera is extended, and decrease as it is reduced, if the stop, subject, light, and plate remain the same, but the exposures are not correctly proportional to the degree of enlargement or reduction.

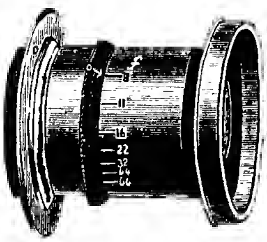

Fig. 68.—Rapid Rectilinear Lens.

Focus of the lens means the distance between the centre of the lens and the point where the rays converge.

Enlarging and Reducing.—In reducing, to find out what distance the lens will be from the copy, add one to the number of times reduced and multiply by the focus of the lens. Thus, to reduce to one-fourth, reduction is four times, add one, multiply by focus of lens (say 18 inches), distance would thus be 90 inches.

To know what Extension of Camera will be required when Reducing.—Divide focus of lens by the number of times of reduction, and add one focal length thereto. *Example*—Focus, 18 inches, reducing to one-third. Reduction is three times, and the extension of camera will be 24 inches.

When enlarging, reverse the order of these calculations, the longest distance being always the camera extension. Always measure distance from diaphragm of the lens.

Copying same Size.—The distance from the copy to the diaphragm will be twice the focus of the lens, and the extension of the camera will also be twice the focus of the lens: or, if the camera is used direct (without mirror box or prism), the distance from copy to ground glass will be four times the focus of the lens.

Artificial Light.—When photography requires to be done under conditions irrespective of the varying changes of daylight, artificial light can be resorted to. Electric light is, undoubtedly, the best

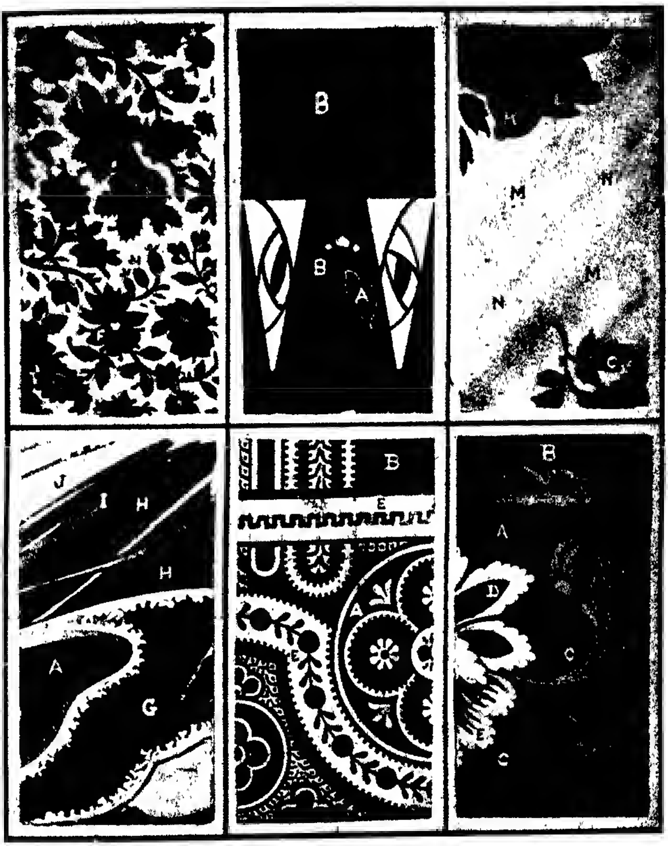

Fig. 69.—Reproduction of Photograph illustrating various Colour Values.

A, Black.	E, Yellow.	I, Mid Brown.	L, Mid Mauve.
B, Red.	F, Pink.	J, Light Brown.	M, Light Mauve.
C, Dark Green.	G, Stone.	K, Dark Mauve.	N, Light Helio.
D, Dark Blue.	H, Dark Brown.		

in the form of two arc lamps, but if unsuitable to have this, the lime light is resorted to by having a cylinder of oxygen and one of hydrogen,

from each cylinder a rubber tube is connected to a stand, on which is fixed a lime burner.

Colour Filters.—As a rule, these are dispensed with for photography used in calico engraving, usually the tone values secured from the various colours being sufficient for the purpose required (see fig. 69). Filters consist of coloured glass, or other transparent coloured media which excludes light of the particular colour which is to be transparent on the negative, and only permits those rays to act on the plate, which are absent in the light reflected from the pigments in the picture. *Example*—Yellow and orange filters absorb (exclude) the violet of the spectrum and more or less of the blue-green. Red filters absorb the yellow-green, green, and blue-green. Blue filters absorb the yellow-green and green rays.

Liquid Filters.—These consist of glass cells with parallel sides about 5 to 10 mm. apart, and filled with solutions of aniline dyes. They are very difficult to work.

Dry Filters.—These consist of stained films of collodion, or gelatine sealed between glass, and are easier to work than liquid filters, owing to being more uniform.

CHAPTER V.

HANDKERCHIEF ENGRAVING.

(Arranged by Sketchmaker.)

The preparation and arranging of plans for handkerchief engraving are specially treated in this chapter, owing to the greater study and manipulation this class of work requires to make it profitable as compared with garment designs. Plans or roughs must be done in a methodical manner, and are as necessary, if successful results are to be obtained, as are an architect's to a builder.

Definition of a Handkerchief.—The question might be asked, what is handkerchief engraving? To answer briefly, we might reply, engraving arranged for a given area.

This definition may seem vague, but when consideration is given to the variety of styles, and all planned and wrought out in a different manner, the definition suffices in a general way.

There is the single handkerchief (one on the roller); then two, three, four, six, eight, nine, or even twelve small handkerchiefs (all different designs) may sometimes be arranged for engraving on the roller.

Some of these may be engraved single hem (edge pattern), others double hem, or broad hem, as termed by the merchant.

The Sarrie, or Jumper, design may also be classed in the handkerchief group.

When arranging these plans it is customary, for economy and also for easy handling, to set out on paper only a quarter of the plan, which is done to the size of the engraving required on the roller. It is, therefore, necessary to arrange the corners and centres correctly, so that when completed on the roller each quarter will appear similar.

Slash is the term denoting the cross-over lines run off the square at a slight angle to prevent the printing "doctor" tearing and dipping the engraving. Pentagraph work can be slashed in the machine from the zinc plate arranged on the square. Hand and die sketches require to be slashed (when necessary) by the sketchmaker.

Fig 70 —Slash Scale

The amount of slash required is adjusted from a scale (see fig. 70) set out on a piece of zinc showing gradations of ½ inch, ¾ inch, and so on in quarter inches up to 2 inches, reckoned at 36 inches wide. From the vanishing point A the distance required is taken on the compasses and marked lightly. The proportion of the required slash on this distance is then measured with the dividers, and transferred to the sketch or zinc plate in process of work.

One Pattern on the Roller (see fig. 71).—Usually the required dimensions are given by the merchant to the engraver, but suppose we arrange a plan for a simple handkerchief (see fig. 72) to print on cloth at 30 inches grey width. The cloth in the process of bleaching would shrink to about 26½ inches—*i.e.*, will be fully one-tenth narrower. The white cloth is then what is termed "clipped"

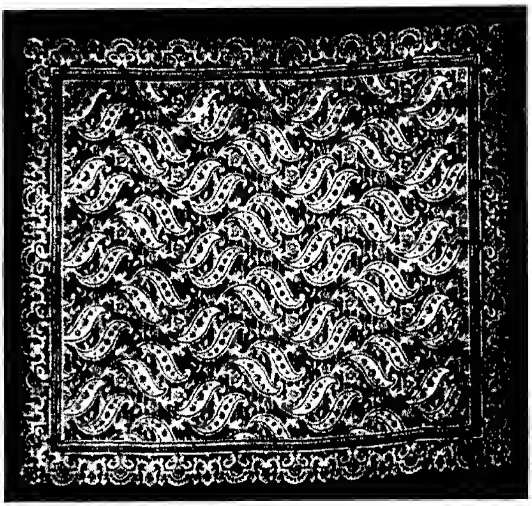

Fig 71 —Photo from Printed Cloth showing Two-colour Handkerchief

in the process of beaming, thus pulling it out about 1 inch wider for the purpose of having it equal in width and giving straight selvedges

when printed. The cloth would then be available for the printing machine at $27\frac{1}{4}$ inches wide.

The sketchmaker would arrange the plan at $25\frac{1}{4}$ inches wide to edge of border, leaving 1 inch for selvedge on each side.

The rollers would be about 28 inches in circumference, leaving 2 inches for gaw or cutting space between each handkerchief when printed. A side square is first raised, and half the width—viz., $12\frac{5}{8}$ inches—marked off. The paper strap, as for garment rollers, is halved,

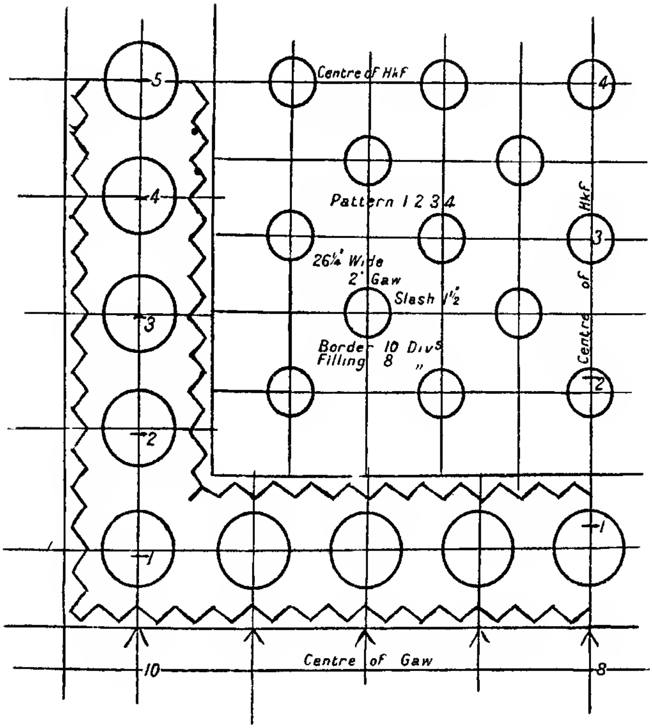

Fig. 72.—Finished Plan for Handkerchief, one pattern on roller. Scale: one-fourth.

but allowing $\frac{1}{16}$ inch instead of $\frac{1}{8}$ inch as in garments for turning off, this size is next marked off, and half the gaw—viz., 1 inch—leaving a skeleton of the quarter dimensions. The centre of handkerchief and centre of gaw are marked as shown on plan to avoid any mistakes, owing to further repeat lines being marked on plan. The width of border is now taken from the design and ruled off, also a line

marked in the centre of border which gives, in this case, corner ball, also point for dividing repeat lines into centres of handkerchief.

When arranging edgings it is an advantage to start the top and bottom at the same point, and thus allow the pentagrapher the benefit of working the cross borders without turning the plate, and also doing both round borders with the same tracing.

The filling is now arranged by setting off a line to strike the centre of the ball next the borders. Repeat lines are then measured out to the centre of the handkerchief.

Setting Out the Plate.—The sketchmaker should arrange the plate for one repeat of border five times larger, making the necessary allowances, as already explained; also a repeat of the filling on the back of the plate (for a simple pattern like fig, 72); this economises the zinc.

Division Lines and Registers.—The division lines on the plan and the registers on the plate are now attended to. These are required by the pentagrapher, owing to repeats for round borders and fillings of handkerchiefs not coming into equal divisions with the circumference of the rollers as in the case of garment designs. The division lines are equal sections of the circumference of the roller nearest to the repeat of the border. Registers are the difference between these sections and the round repeats.

Setting off Corners ("chase round").—For planning out a handkerchief of a floral character, the skeleton plan is made out in the same manner, but the setting off for the corner object is entirely different. Fig. 73 is an illustration of a "chase round" border, so named owing to each of the borders turning one-quarter.

First, an outstanding point is fixed, which appears on round and cross border near the corner. This point is measured off from the edge of the handkerchief in the cross border and applied into the round. The difference between this radius and the same point in the round is subdivided. The repeat of the pattern is now marked from this balance point (round and cross) back into the corner object, thus marking off the starting point square at the corner, also giving a repeat line upon which the flower will chase round. The repeat lines are now divided off into centres of handkerchiefs.

Lines, according to the repeat of the plan, are then set out on a piece of transparent paper, and a rough outline of the flower traced in pencil. The paper is then turned over and this same outline traced with a soft or transfer black. The rough sketch is now transferred to the plan by rubbing with the thumb nail, or burnisher, and repeated right round the quarter plan. By this method a dozen or more

transfers can be set down, and these are usually sufficient to cover the plan.

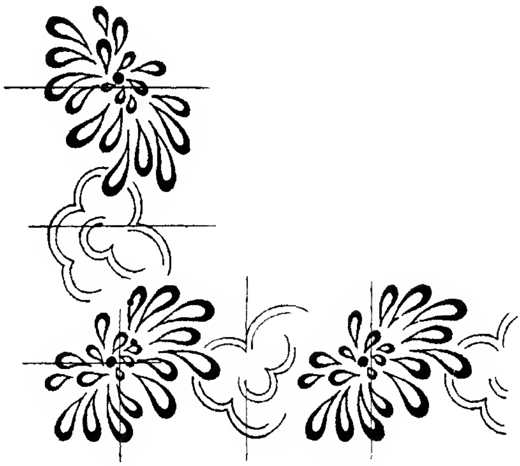

Fig. 73.—Showing "Chase-round" Border

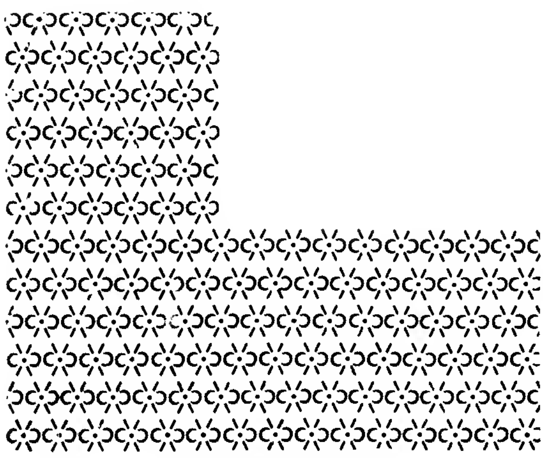

Fig. 74.—"All-over" Pattern

All-over Arrangements.—Some borders of handkerchiefs can be profitably arranged to work as all overs (see fig. 74). This is equal to

planning the pattern as if the work was also to cover the filling, but the engraving is placed on for width of border alone, either by the pentagrapher dropping diamond points as required, or placing the engraving all over, if suitable, and then painting out the centre.

Reverse Corners.—It not infrequently occurs that the designer draws only one border for a handkerchief pattern, which requires to be arranged on the plan for reversing into the round border. In this case a simple method is adopted to hold a thin glass mirror, or a piece of highly-polished zinc, at the angle of 45 degrees (thus showing the reverse border), and by moving the mirror backward or forward the best arrangement can be fixed prior to starting the plan. When the corner is decided upon, a pencil line should be drawn on to the design against the edge of the mirror.

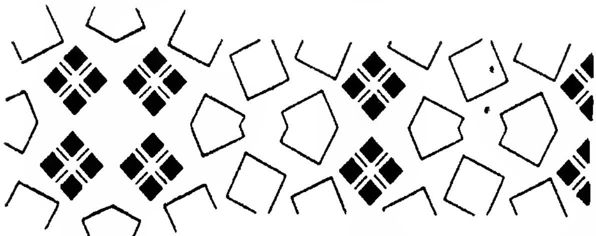
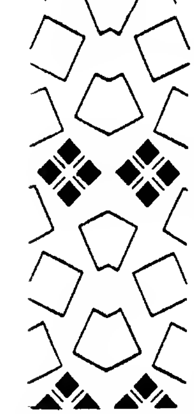

Fig. 75.—Double Hem as engraved on the Roller

Single Hem or Edge Patterns (see fig. 81) are so named for small pocket handkerchiefs in distinction from double hems. They have only one border, and usually about $\frac{3}{4}$ inch selvedge.

Double Hem (see fig. 75).—These are patterns engraved with the border reversed all round the handkerchief. When printed they are hemmed back to back, and represent duplex work; the one border must, therefore, be a reverse of the other. A point to be noted for all double-hem engraving is the small gaw, usually $\frac{3}{8}$ inch, which is just sufficient when cut through the centre to allow for folding in when hemming, and thus show no selvedge as in single or edge patterns. Owing to this the cloth requires to be clipped very exact for printing, according to the width of engraving.

Two Patterns on Roller (double hem).—With this arrangement the two patterns are engraved in the width, each design occupying the

circumference of the roller. Suppose fig. 76 is a plan for this style, say $35\frac{5}{8}$ inches wide, $\frac{3}{8}$-inch gaw, and 1-inch double hem, roller 18 inches in circumference. The sketchmaker raises a square in the centre of the paper; for arranging the half width on each side the simplest way is to add the $\frac{3}{8}$-inch gaw to the width given, which would make it 36 inches. Divide this with compasses into four parts, and throw off one section on each side, which gives the centre of each handkerchief. It is advisable always to keep the plans slightly within the given width (say, $\frac{1}{8}$ inch), owing to the pentagraph machine always inclining to travel wide. Then take the half of the gaw and mark off on each side of the centre line, also at cross-over line. Half the circumference is next marked on, and plan finished as for one pattern on the roller.

When arranging the work, the inside half of the hem must be

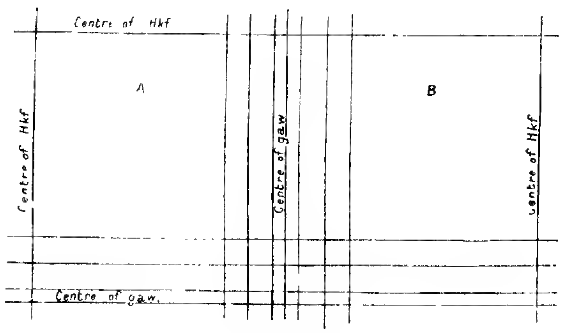

Fig 76.—Skeleton Plan Representative of Two Patterns on Roller Double hem.

attended to, and set off in the same manner as explained for the single handkerchief. The other half of the hem next the gaw must be a reverse in every detail of the inside.

For the plate it is economical (unless the repeat is large and has elaborate detail) to engrave both halves of the hem, also to complete the full corners, and to extend the engraving into the centre of the gaw—*i.e.*, filling the "lugs," to use the engravers' vernacular—thus allowing the pentagrapher to "place on" the engraving much quicker and with less risk of misfit, compared with the supposed economy of engraving one-half of the hem, which necessitates a vast number of movements by changing the positions of the plate. If fillings were also on the design this might require four sets of divisions on the plan, and also on the roller. This would, undoubtedly, lead

to complications. It is, therefore, advisable to arrange two sets of divisions between the repeats.

Three Patterns on Roller (double hem).—Each design is also engraved once in the circumference. The rollers require to be wide to suit the width of the engraving. This style is for small handkerchiefs, but garment rollers are found quite convenient.

It will be noticed in this case that two spaces or gaws are required between the three patterns. Fig. 77 is representative of a plan 45 inches wide, $\frac{3}{8}$ inch gaw, $\frac{1}{2}$ inch double hem, and 15 inches circumference.

When arranging the plan, a full width must be shown in the centre, but detail of setting out one-half will suffice with the usual half width for the outside patterns. For setting out the skeleton lines, the simplest way is to add two gaws to the given size—*i.e.*, $\frac{3}{4}$ inch on to the 45 inches—then with the compasses divide into six. Each of these

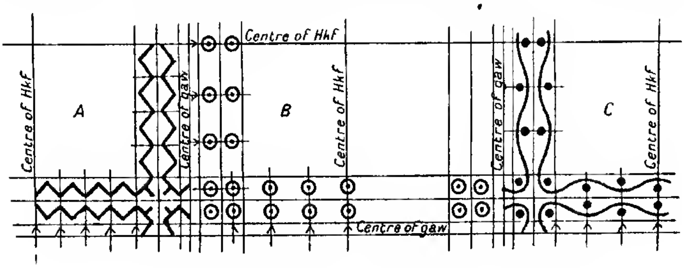

Fig. 77.—Plan showing Three Patterns on Roller. Double hem.

sections is representative of a centre. Mark two on each side of the centre with the gaws, as shown on plan, and the circumference treated as already explained, and the $\frac{1}{2}$-inch hem marked on double. Where edgings or runners occur on designs inside of hems it is always advisable to arrange them at the same repeat as the hem, thus obviating a double setting and also much expense when engraving in the pentagraph machine. Again, in this, as in all cases, endeavour to arrange two sets of divisions, and complete the hems and full corners on the plate.

Four Patterns on the Roller.—These are arranged with two patterns across and two around the circumference. For planning out, the width is set out as a two on the roller, but remember for the circumference there must be an allowance for two gaws (see fig. 78). The easiest way is to halve the given circumference, *minus* the allowance for turning off, and mark this size on each side of the centre square. The gaws are, therefore, arranged in the centre of the plan, and the details for repeats as in other patterns.

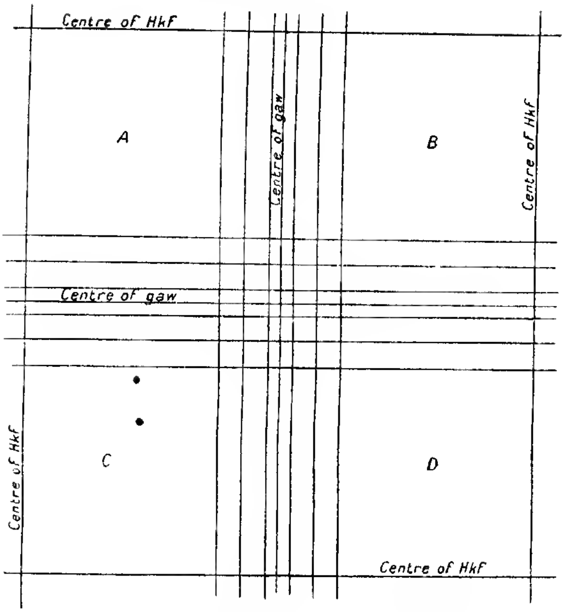

Fig 78.—Skeleton Plan Representative of Four Patterns on Roller. Double hem.

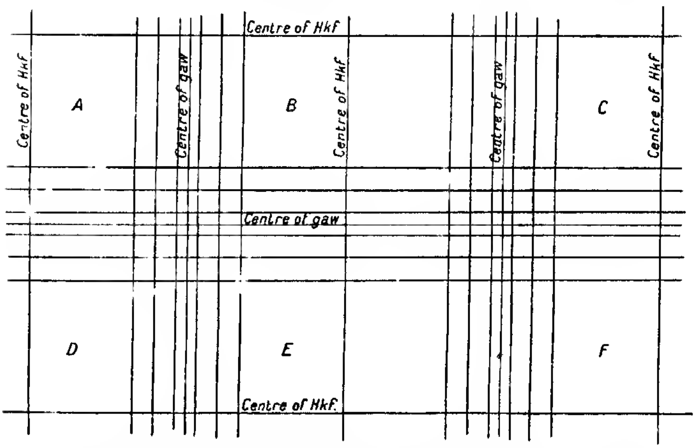

Fig 79.—Skeleton Plan Representative of Six Patterns on Roller. Double hem.

Six Patterns on the Roller.—The width is proceeded with as a three on the roller, but the circumference, owing to the two gaws being also required, as for four patterns on the roller (see fig. 79).

Eight Patterns on the Roller.—Here the arrangement comes in different. There must be three gaws or spaces between the four handkerchiefs across the roller, and the two gaws for the two handkerchiefs in the circumference. These are invariably single hems, or edge patterns.

It is usual to take the width *plus* the three gaws and divide this into eight. The radius on the compasses will then give the centre of each gaw and the centre of each handkerchief. The plan will show two handkerchiefs full width across and one-half at each side (see fig. 80), also half width of each in the circumference.

Nine Patterns on the Roller.—For this plan the arrangement is set out with three patterns in the width and in the same manner for securing the centres of the handkerchiefs. There are also three patterns arranged in the circumference, as shown in fig. 81.

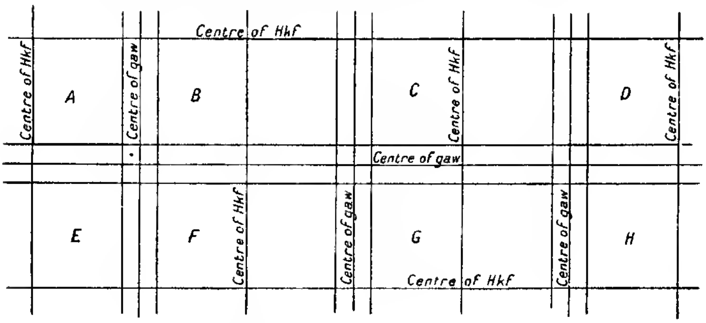

Fig. 80.—Skeleton Plan Representative of Eight Patterns on Roller.

The size of the roller is divided into six sections, this radius, when marked on the plan, will give the centre of the handkerchief and gaw for each pattern. They are also invariably edge patterns.

Twelve Patterns on the Roller.—This is a laborious arrangement, but, fortunately for the engraver, is seldom resorted to. It is employed from an economic standpoint for very small sizes, owing to some special cutting of prices. It certainly works out well in printing, notwithstanding the extra labour it involves in engraving and cutting and hemming when the goods are finished.

The sizes of these handkerchiefs must, consequently, be small, about 11 inches square, and always have single or edge borders. The width of the engraving over all would be about 46 inches wide, with $\frac{3}{4}$-inch gaws, the circumference of the rollers would be about 36 inches.

Four patterns are planned in the width, as explained for eight patterns, and three patterns for the circumference. There must be the skeleton of two full handkerchiefs in the centre, as shown in fig. 82, and the plan so set out as to allow for three gaws in the circumference; thus the more handkerchiefs that are placed on the roller the greater the risk of misfit will be, and should this mishap occur on a roller, such as described in fig. 82, it is usually found that several

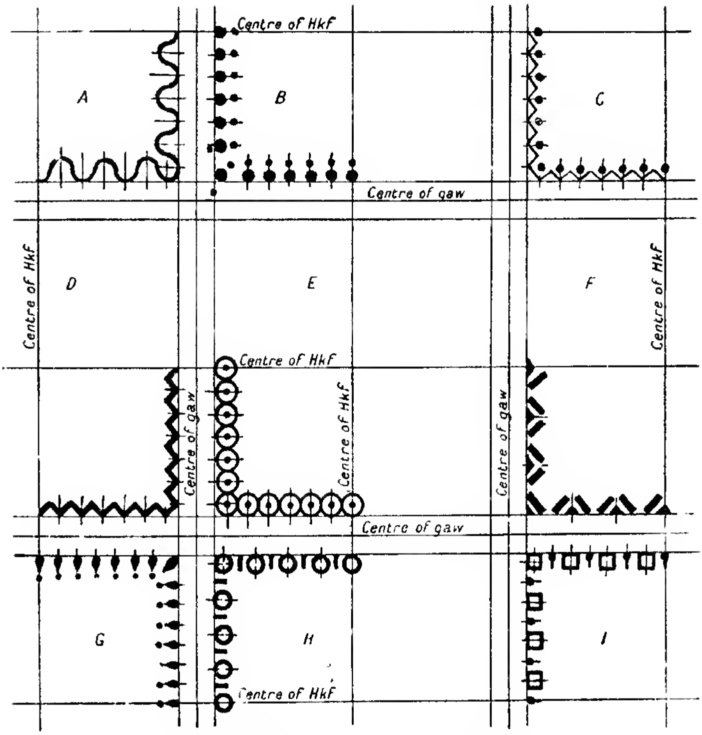

Fig. 81.—Plan showing Nine Edge Patterns on Roller.

are out of register. The result is, consequently, serious, and may compel the turning off and re-engraving of the roller. A good safeguard for all handkerchief patterns is to procure as many mandrels for the machine as there are colours in the pattern, as the rollers require to be often out and in the machine, but need never be respindled if this plan is adopted. Every chance is thus given to secure a good fit, which should be tested in all cases by the hand engraver after

the rollers are etched, and previous to more labour being expended on them.

Further, security of fit is obtained by the pentagrapher making a cross in the centre of a gaw, and testing this every time the roller is replaced in the machine.

The circumference on which handkerchiefs are engraved varies from sizes much less in circumference than an ordinary garment, say, about $11\frac{1}{2}$ inches in circumference up to 40 inches in circumference. These small bores are smaller than universal size, and give trouble to the printer. It is, therefore, usual to engrave the same patterns twice on the roller 23 inches in circumference, and thus allow the

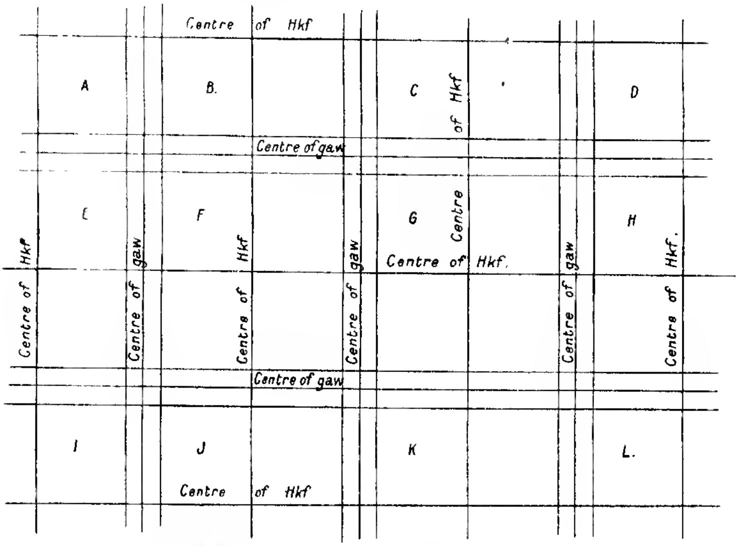

Fig 82.—Skeleton Plan Representative of Twelve Patterns on Roller

universal bore to be used in the case of electro rollers, and large bores with solid copper.

It is evident that in connection with handkerchief engraving there is great scope for ingenuity of thought and planning, not only for sketchmaking, but also in pentagraphing by arranging levers and brackets to secure as many sketches as possible from the same tracing.

Sarrie Patterns, or "jumpers," as they are known in the trade from the method of printing in a machine specially built for the purpose. —With the ordinary printing machine all the rollers composing the pattern must be of the same circumference, but with the "Sarrie"

the rollers are of different circumferences, but must be a multiple of each other. This class of work might be termed half a handkerchief and half a garment. Usually there are two colours. The "header"

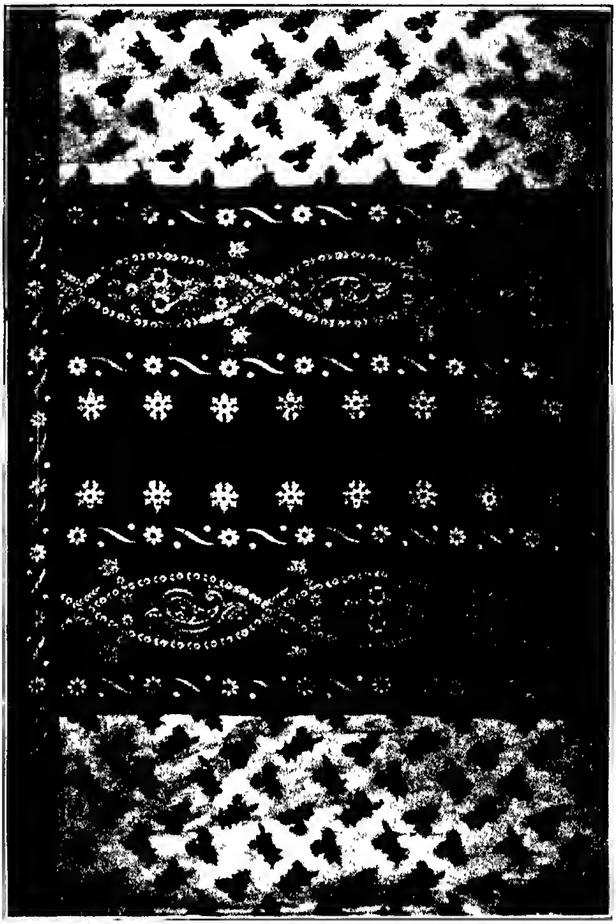

Fig 83.—Photo from Printed Cloth showing Section of Sarrie, or "Jumper," Pattern. Two colours = four rollers.

rollers are 36 inches in circumference, on which the "header," or large border, is engraved across the roller, and the "dada," or narrow

border, engraved around the roller up to the width of the "header" and also $\frac{1}{32}$ inch beyond, to ensure the "dada" of the filling rollers linking exact with that of the "dada" on the "header" rollers, as shown in fig. 83.

The "header" must be engraved twice across the roller, and the one border "chased" from the other. Between the borders is a gaw, or cutting space, of 2 inches, in which respect it partly resembles the handkerchief character. The engraving must on no account be "slashed," because, owing to the roller dropping parallel out of and into position in the machine, the engraving must be parallel also. If continuous lines run across the roller, small "bridges" or whites are placed at intervals in lieu of the slash, thus preventing the "doctor" from tearing the lines.

The filling rollers are 18 inches in circumference, and on these cylinders are also engraved the "dada" completely round the rollers, on the same principle as for an ordinary garment. If the design was suitable these filling rollers could also be printed as for an ordinary double-border garment.

In printing, any multiple of the filling roller can be run off before the "header" roller is allowed to drop in once.

Usually the "header" is dropped in to give a border across the piece every 8 feet, which is afterwards divided on the space between the "header." These prints are used as loose costumes by the natives of Africa.

CHAPTER VI.

ZINC OR PLATE CUTTING.

THIS may be described as tool making for the pentagraph machines.

Plate Cutters' Table.—After the sketchmaker has accomplished his part, the zinc is forwarded to the plate cutter, who fixes it with a few $\frac{3}{8}$ inch gimp tacks on the top of the turntable (see fig. 84),

Fig. 84.—Plate Cutter's Turntable.

which is most useful for swinging it round to facilitate the engraving, or an iron rod with a tapered end is carried down to the floor, and rests in a socket. The rod is further supported beneath the bench, and at the top four arms spread out, on which is fixed the small table 16 inches square. To suit larger plates two tables, 24 and 30 inches

square, have a deep beading which telescope on the top of the small table, and are thus made rigid for engraving upon.

In practising the art of plate cutting the apprentice ought to learn in the first place how to hold his graver (see fig. 149). It is imperative he should begin with the single point, holding it square so that an equal ¯\/ shaped line is engraved. If the graver is held off the square, a line will be cut after this manner, ¯\ ‘ ¯. This hint requires special attention when using two-point gravers, otherwise one of the teeth will be deeper than the other, and give trouble in tracing to the pentagrapher. Again, when engraving a quick curve he will do well to gently turn the table while going round the shape to avoid any "jerks" on the line. Apart from the pentagrapher taking longer to trace a badly engraved zinc, the transference to the roller always leaves marks of these defects, and the work is, consequently, not so perfect as when the engraving is done in a smooth and even manner.

Previous to starting the engraving the instruction sheet is con-

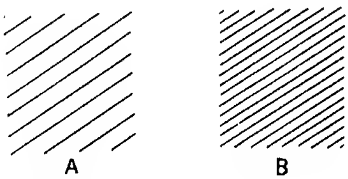

Fig. 85.—A, Ten ground (part etch) — 50 lines to inch on roller; B, Twenty ground (single etch) – 100 lines to inch on roller.

sulted, the grounds noted, allowances and indents given in accordance with the style of design and the particular class of engraving desired. This is a most important point for study, and one which has much to do with the success or otherwise of the engraving when the rollers come to be printed.

Grounds (see fig. 85) are a series of parallel lines engraved on the angle, thus resisting better the action of the doctor; this also prevents "stripping" when printing. The lines which form the ground are engraved for the solid parts of the design in order to better retain the colour, and thereby prevent undue flushing during the process of printing.

They are engraved, according to various scales, as explained for the different styles of engraving. Part etch and fine grounds are accomplished in the pentagraph machine or on dies. The other method is done with a ruling mill in the ruling machine, as explained in Chapter XX.

Allowances (see fig. 89).—These are small spaces between colours to prevent one edge overlapping on the other, which may give a different tone of colour to the edge, and constitute a defect on the print. The amount required is regulated in accordance with the enlargement on the plate and also the nature of the engraving, as detailed on the tables in connection with this chapter.

Fig. 86.—Indents at Three Enlargement.

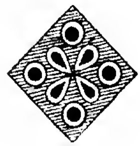

Fig. 87.—Showing Small Shapes "Saved."

Indents.—This is an opening running into a solid shape, such as a serrated leaf, as shown on fig. 86. It requires to be large enough when printed to show a vein of white sufficient to give point to the shape. It also must be regulated in size, as explained in tables which follow.

Fig. 88.—Traced from Pattern.

Saves.—When small shapes are surrounded by colour, and in order to prevent them being obscured or toned with the surrounding colour, they are what is termed "saved for," as illustrated in fig. 87; it is protected by an allowance or space all round.

Two-colour Pattern.—Fig. 88 is a representation of a two-colour

pattern for ordinary print on white ground work. It is enlarged three times, and traced direct in the opaque camera on to the zinc. In this case the plate cutter requires to allow four-hundredths on the outside shapes (equal to two-hundredths on each side), gauging this amount with the eye while cutting within the drawn line. He next proceeds to mark off the allowance (No. 10, two-point graver) between the colours, and also cuts the two-point (six graver) at the parts required for the part etch.

Fig. 89 represents it ready for the pentagraph machine.

It will be observed that the indents and allowances in the various enlargements do not graduate in relation to the enlargements. This

Fig 89.—Showing Engraving finished by Plate Cutter.

is based on practical working– that is, when the engraving on the zinc is transferred to the roller the same amount of "swell" naturally takes place in the process of etching.

A scale for fine garments at three enlargement and scales for fine, as well as ordinary, at two and a half enlargement are omitted. They are seldom used, owing to their being almost impracticable, and, further, the pentagrapher requires to trace much slower than when done on a larger scale.

The range of grounds, indents, and allowances for handkerchief work should commence with the coarse scale used for garments, and get coarser as the work is required stronger.

Tables showing the Grounds and Allowances for Various Styles of Work.

	Part Etch.	Fine Etch.	Size of Indents.	Allowance off Bondage.	Allowance between Colours.
5 Enlargement.	Ground	Ground	Hundredths.	Graver	Graver
Fine garment print on work,	80	140	10	10	11
Ordinary ,, ,, ,,	65	120	12	11	13
Coarse ,, ,, ,,	50	100	14	12	14
Discharge ,, ,, ,,	40	90	18	14	16
3 Enlargement.					
Ordinary garment print on work,	65	120	9	9	10
Coarse ,, ,, ,,	50	100	11	10	12
Discharge ,, ,, ,,	40	90	15	12	14
2½ Enlargement.					
Coarse garment print on work,	50	100	10	9	11
Discharge ,, ,, ,,	40	90	12	11	13

Note.—The scale of grounds indicates the number of lines per inch on roller, to find the ground plates required, divide by the enlargement on the zinc plate.

Turkey-red Discharges.—The large allowance between the colours for this class of engraving is accounted for by the necessity of requiring a small space (or line of ground) to show on the cloth between the colours when printed. At five enlargement it may be $\frac{26}{100}$ to $\frac{28}{100}$ for indents, and $\frac{18}{100}$ between the colours. At three enlargement, about $\frac{17}{100}$ for indents and $\frac{15}{100}$ between the colours.

Single and Two-point Cutting.—In small parts, as shown at point marked A, fig. 89, single line formation of the shape only is required for the fine ground, but with the larger pieces of colour, as marked B on same figure, which requires half or part etch, it is desirable to engrave a two-point line, thus giving security for clean edges from the pentagraph grounding. If single line engraving is adopted as described, the pentagrapher requires to exercise greater care, otherwise ragged edges will appear on the engraved roller.

The two-point cutting is varied according to the nature of the work and the enlargement of the design on the zinc. No. 6 is used for fine garment work, and No. 8 for ordinary work, but no opener than a No. 9 should be employed, even for very coarse work, as it shows the outline too "teethy" when etched.

Measuring.—Any small whites, solids, spots, or rings are measured with the hundredth-part scale and the aid of the magnifying glass. The size measured is multiplied by the enlargement of the design on

the zinc; the allowance, according to the class of work, is added for whites and deducted for solids.

Suppose a solid spot was measured on the design as $\frac{7}{100}$ (for five enlargement); this figure is multiplied by 5, making 35. Five-hundredths are then deducted for allowance, and the spot drilled on the zinc with the No. 15 bit, making $\frac{30}{100}$ for the full diameter of the circle.

Drill Bits.—These usally range from Nos. 4 to 30, which is equal to $\frac{8}{100}$ up to $\frac{60}{100}$ in diameter when circled. They are graded in half

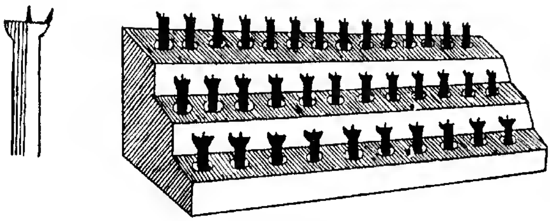

Fig. 90.—Drill Bits and Stand.

hundredths for each bit, arranged on a stand (see fig. 90), and used as follows:—

The centre of the circle is first lightly marked on the zinc with a centre punch, the "bit" is then fixed in the drill, placing the centre

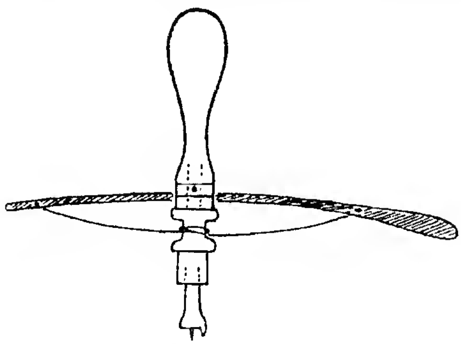

Fig. 91.—Drill and Bow. Scale 1½ = 5 inches.

of "bit" on the centre of the circle, and the bow (see fig. 91) moved backward and forward to give a rotatory motion.

Rings.—For pin work small ring punches are used up to $\frac{8}{100}$ to meet the drill bits. They graduate down to the smallest circle possible to trace in the pentagraph machine (see fig. 92). The zinc is laid

on a large smooth iron plate to give solidity when striking the punches with the hammer. Care must be exercised when working ring punches to have the centres cleaned out frequently with the aid of a single point graver, and touched on an oil-pad, otherwise the cavity inside the ring will get choked with paint from the zinc, and burst the edges of the ring.

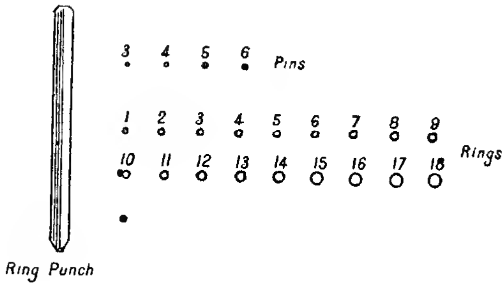

Fig 92 —Pin and Ring Punches

Filling In.—Parts in any design of a flowing or trailing nature, and somewhat parallel in width (see fig. 93), can be filled up with lines in relation to the grounds used for other parts of the same colour, thus saving a great amount of time for grounding in the pentagraph

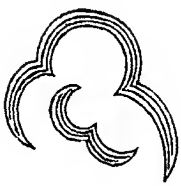

Fig. 93 —Showing Parts "filled," or "split up," with Lines to save Grounding.

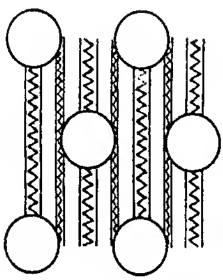

Fig 94 —Round Lines filled with "Zig."

Fig. 95 —Traverse Point

machine. It should be noted that it is advisable to "fill in" these parts rather finer than the grounds used, as they do not strip so readily as ordinary grounds during the process of etching. Cross-over lines are

"filled in" after the same manner, but require to be chiselled or milled when engraving is completed on the roller.

Zigs.—Straight lines in the circumference of the roller, and when broken up with objects, can, with advantage, be filled with a "zig" on the plate (see fig. 94). The ziging leaves a "knurl," or roughness, in the bottom of the line, and prevents the colour from stripping in the process of printing.

This method can only be done with lines from $\frac{7}{100}$ up to $\frac{10}{100}$ in width at five enlargement, and $\frac{4}{100}$ up to $\frac{7}{100}$ at three enlargement, and is only advantageous when well broken up with sprigs. When

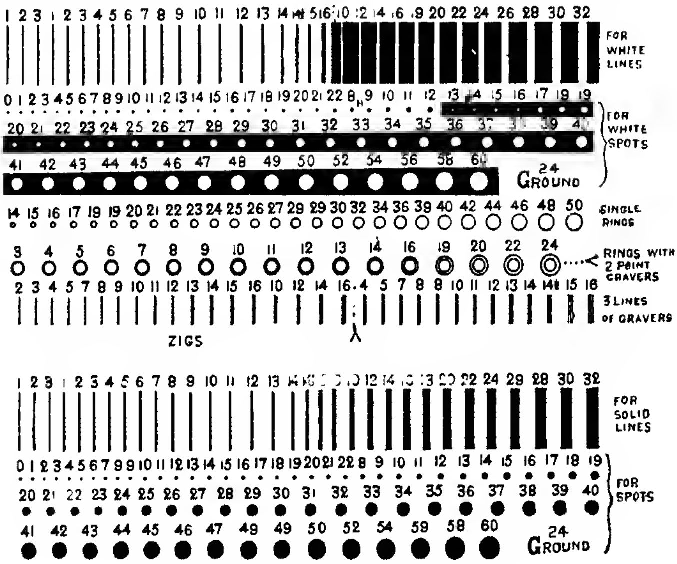

Fig 96—Plate Cutter's scales for Five Enlargement.

large stretches are on the design it is quicker to split or fill the lines in the usual method, and mill them afterwards.

Traverse Points.—For marking off large allowances or spaces beyond the scope of the graver, traverse points are useful (see fig. 95). These usually range from $\frac{8}{100}$, and are graded in hundredth parts up to 25. When drawing the line they must be held square, otherwise unequal divisions will be the result.

Scales.—The scale represented in fig. 96 is from a cloth impression off a roller. The engraving was done from a plate enlarged five

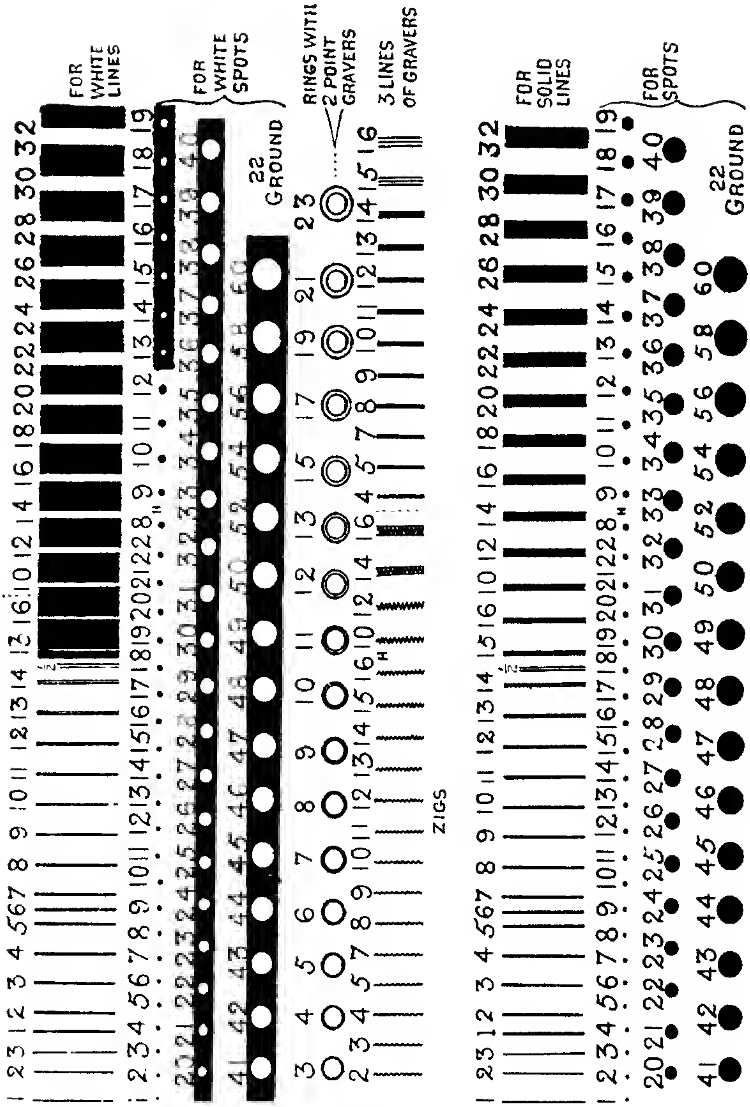

Fig. 97.—Plate Cutter's Scales for Three Enlargement.

times, and reduced in the pentagraph machine. Fig. 97 is a similar scale for three enlargement on the plate. They are useful to the

sketchmaker and plate cutter as guides in deciding the size of small whites and solids on the design, but they should only be referred to in a general way, because the various grounds to suit the particular class of design require different allowances, as shown in tables.

Gravers, Single Point.—Only one grade need be used, as no matter whether a line is cut with a sharp or a flat graver, it can only be the same when transferred on to the roller with the scratch of the diamond point, therefore the only consideration is, what is the best single-point graver to use for plate cutting? No. 4 is found to suit admirably, this being a good medium between a sharper graver, which would, undoubtedly, incline the pentagrapher's tracing point to stick in the line, and a flatter graver which would conduce to slips when tracing, owing to the engraved line being too shallow.

Gravers, Two Point (see fig. 98).—They range from No. 2, the

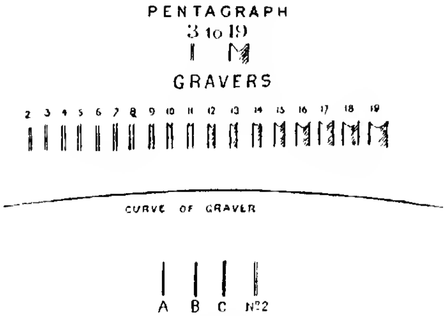

Fig. 98 —Pentagraph Two-point Gravers

teeth being $\frac{1}{100}$ inch apart, up to No. 19, the teeth of which is $\frac{12}{100}$ apart, getting opener and deeper in the teeth as the numbers advance. These two points are called pentagraph gravers, owing to the higher numbers being used alone in this department. No. 2 is the finest that can be used in a practical manner. Finer than this might be engraved on the plate, but the pentagrapher could not make a satisfactory tracing on the roller. Even with a No. 2 great care requires to be exercised, as it is most important to have clean smooth cutting by observing that the graver is held in the proper manner. It is also requisite to have an equal depth of teeth.

Gradation of Lines.—When a fine gradation of lines is required, say, from a No. 2 two-point down to a single line (see fig. 98), it is better to have the three lines next the finest two-point engraved single. The pentagrapher can trace A once, B twice, and C three

times, thus securing a nice gradation. This also avoids showing a sudden contrast from the two point on to the single line.

Two-point gravers in relation to the $\frac{1}{100}$ part scale, also the number of lines each gives to the inch (fractions being omitted).

Gravers	Hundredth parts of inch.	Number of lines to the inch	Gravers	Hundreth parts of inch	Number of lines to the inch
No 2 two point,	1	100	No 11 two point,	$3\frac{1}{2}$	29
,, 3 ,,	$1\frac{1}{8}$	88	,, 12 ,,	4	25
,, 4 ,,	$1\frac{1}{4}$	79	,, 13 ,,	$4\frac{1}{2}$	22
,, 5 ,,	$1\frac{3}{8}$	72	,, 14 ,,	$5\frac{1}{2}$	18
,, 6 ,,	$1\frac{1}{2}$	66	,, 15 ,,	7	14
,, 7 ,,	$1\frac{3}{8}$	57	,, 16 ,,	8	12
,, 8 ,,	2	50	,, 17 ,,	9	11
,, 9 ,,	$2\frac{1}{2}$	40	,, 18 ,,	10	10
,, 10 ,,	3	33	,, 19 ,,	12	8

The following tables show the gravers used for filling or "splitting" various widths of lines, also the ground plates with which they harmonise (as near as possible), and the number of lines per inch on roller.

For Five Diminution.

4 lines of	13 graver		equals an	8	ground or	40	lines per inch on roller,
4 ,,	12 ,,		,, a	9	,,	45	,, ,,
4 ,,	11 ,,		,, a	10	,,	50	,, ,,
4 ,,	10 ,,		,, an	11	,,	55	,, ,,
4 ,,	9 ,,		,, a	12	,,	60	,, ,,
4 ,,	close 9 ,,		,, a	13	,,	65	,, ,,
4 ,,	on 8 ,,		,, a	14	,,	70	,, ,,
3 lines of	11 gr splits a	15 gr	and equals a	15	,,	75	,, ,,
3 ,,	10 gr splits an open	$14\frac{1}{2}$	,, ,,	16	,,	80	,, ,,
3 ,,	close 10 gr splits a	$14\frac{1}{2}$	,, ,,	17	,,	85	,, ,,
3 ,,	of 9 ,,	14	,, ,,	18	,,	90	,, ,,
3 ,,	of 8 ,,	13	,, ,,	20	,,	100	,, ,,
3 ,,	close 3 ,,	12	,, ,,	22	,,	110	,, ,,
	An open	12	graver equals a	24	,,	120	,, ,,
	An	11	,, ,,	26	,,	130	,, ,,
	A	10	,, ,,	28	,,	140	,, ,,
	A	9	,, ,,	30	,,	150	,, ,,
	An	8	,, ,,	32	,,	160	,, ,,

For Three Diminution.

3 lines of	a close 12 gr	splits a 16 gr.	and equals an	8	ground or	24	lines per inch on roller.
3 ,,	an 11	,, 15	,, ,, a	9	,,	27	,, ,,
3 ,,	a 10	,, $14\frac{1}{2}$	,, ,, a	10	,,	30	,, ,,
3 ,,	a 9	,, 14	,, ,, an	11	,,	33	,, ,,
3 ,,	an 8	,, 13	,, ,, a	12	,,	36	,, ,,
3 ,,	a close 8	,, 12	,, ,, a	13	,,	39	,, ,,
3 ,,	an open 7	,, 12	,, ,, a	14	,,	42	,, ,,
3 ,,	a 7	,, 11	,, ,, a	15	,,	45	,, ,,
3 ,,	a 6	,, 10	,, ,, a	16	,,	48	,, ,,
		A 9	graver equals a	17	,,	51	,, ,,
		An 8	,, an	18	,,	54	,, ,,
		A 7	,, a	20	,,	60	,, ,,
		A 6	,, a	22	,,	66	,, ,,

sketchmaker and plate cutter as guides in deciding the size of small whites and solids on the design, but they should only be referred to in a general way, because the various grounds to suit the particular class of design require different allowances, as shown in tables.

Gravers, Single Point.—Only one grade need be used, as no matter whether a line is cut with a sharp or a flat graver, it can only be the same when transferred on to the roller with the scratch of the diamond point, therefore the only consideration is, what is the best single-point graver to use for plate cutting? No. 4 is found to suit admirably, this being a good medium between a sharper graver, which would, undoubtedly, incline the pentagrapher's tracing point to stick in the line, and a flatter graver which would conduce to slips when tracing, owing to the engraved line being too shallow.

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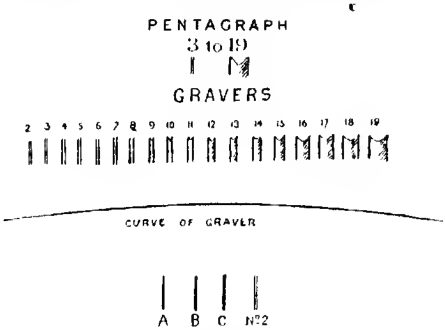

Fig. 98 —Pentagraph Two-point Gravers

teeth being $\frac{1}{100}$ inch apart, up to No. 19, the teeth of which is $\frac{12}{100}$ apart, getting opener and deeper in the teeth as the numbers advance. These two points are called pentagraph gravers, owing to the higher numbers being used alone in this department. No. 2 is the finest that can be used in a practical manner. Finer than this might be engraved on the plate, but the pentagrapher could not make a satisfactory tracing on the roller. Even with a No. 2 great care requires to be exercised, as it is most important to have clean smooth cutting by observing that the graver is held in the proper manner. It is also requisite to have an equal depth of teeth.

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Paste Printing.—The engraving for this style requires a special large allowance, mainly owing to the great depth of engraving and consequent extra swell in the process of etching, although there is less " flush " when printing than in the ordinary work.

Chintz Designs.—These are white grounds, and usually have four colours—yellow, red, pink, and olive. The red invariably gives the principal formation of the rose heads, or the pine shapes, which are a characteristic of this style. The fine parts of the red are allowed to fall on. A good medium red can be obtained with fine shades of the red falling on the solid pink. A chocolate effect is also got with the red falling on olive, and a good orange tint by the pink falling on the yellow. The grounds for this class of engraving are the same as ordinary print on work.

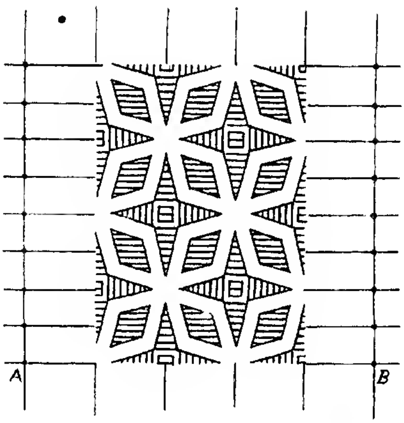

Fig. 99.—Section from Plate of Penta Die Traverse.

Two Pinks.—In the class of handkerchief work known in the trade as two pinks (but really red and pink), all the fine parts of the red should not only be allowed to fall on the pink, but it is preferable to engrave line on line for the larger parts—*i.e.*, no saving, and using the same lines for both colours.

Photo Work.—Designs that are photographed direct on to the zinc plate must get a larger allowance off all outside shapes when engraving, but between the colours they get the same allowances as designs traced in the opaque camera. This is owing to the recognised system of the sketchmaker tracing on the colour, whereas the photograph gives the full and true edge of the colour.

Penta-die Plates.—Plate cutting for penta-die work requires all the allowances to be about one-third less than for ordinary pentagraph plates. There is less swell when etching steel than copper, and the work is invariably of a finer nature. For penta-die traverse work the ground requires to be very accurately set out on the plate by the sketchmaker, and similar on each repeat (see fig. 99). The cross divisions A B on each side of the figure, and repeating with the design, are required for clamming purposes. The diemaker punches a pin as marked at each line; this assists the sectional repeat to link perfectly into each of these "snags" when raising the mill.

CHAPTER VII.

PENTAGRAPH ENGRAVING.

CRADLE MACHINE.

(Rigby Principle.)

Construction and Working of the Machine.—The pentagraph machine was introduced by a Frenchman named Dewerill in 1834. Since then various improvements have been placed on the market and named after their inventors—*e.g.*, Garside, Shield, Rigby, etc. The working of all these machines is somewhat similar, but undoubtedly the Rigby system is the most modern, and it will be sufficient to describe the construction and working of this machine, as shown on fig. 100.

The pentagraph, or pantograph, is an instrument used to reduce, enlarge, or copy, according to the requirements of the work in which it is employed. In calico engraving it is adapted for reducing designs in repeats.

It is well understood and admitted that where fine detail exists in any design, the best method of procedure is to begin with an enlargement, and then reduce to the size required. The pentagraph machine is an ideal medium for this purpose, and might be aptly termed the reducing engraving machine.

The details of the design are first enlarged on the zinc plate, as explained under sketchmaking and photography.

The plate cutter then engraves this zinc or tool as detailed in plate cutting, and the engraving is thereafter transferred from the plate to the roller in reduced form by means of the pentagraph machine in a manner not possible by any other hand method.

The frame of the machine is made of strong cast iron (see A A, fig. 100), spreading well out towards the floor, which imparts steadiness, and is bound together by the triangular support B under the cradle C, which gives support towards the centre. The iron frames D D towards the top, on which the lever rail rests, also give support and furnish the required steadiness when working.

This machine only admits of reducing five times, with power for slight adjustment, as explained later.

There are two direct motions, one for across the roller and the other for the circumference.

To obtain the cross motion, there are two pulleys fixed to a small rod which work conjointly, the one at the bottom, E, being five times larger than the one at the top, F. The larger pulley receives the movement when tracing, and simultaneously conveys it to the small one, around which are wound two short bands (see fig. 101, A) which

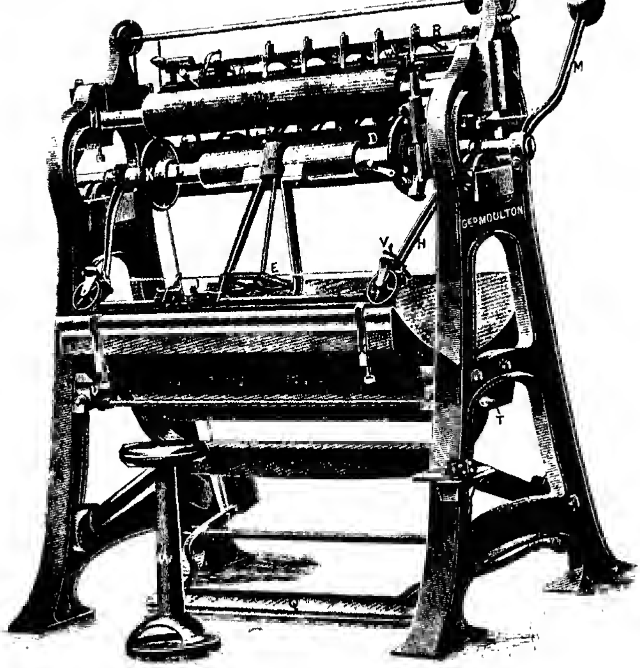

Fig. 100.—Cradle Pentagraph Machine (Rigby principle).

are clipped on to a small frame fixed to the lever rail G, fig. 100, thus moving it one-fifth of the tracing done on the plate.

Around the large pulley is attached the driving band which is stretched across and wound round the double pulleys of the tracer arms H, thus giving a stretch across the cradle of 36 inches, and, consequently, fully 7 inches on the roller.

Fixed on a socket of the tracer arm is a triangular rod I, on which

the tracer carriage J runs. The triangular rod, it should be noted, is of a peculiar construction. Two of the edges are flat, to give smooth running for the wheels of the carriage, and one edge is V shaped, which prevents side play and keeps the carriage in position.

For the motion in the circumference (see fig. 101, B) there is the cradle C, fig. 100, which is five times larger than the discs K on which the ends of the roller rests. The face of the discs are file-cut to prevent the roller from slipping when in motion; thus any movement on the surface of the cradle conveys the engraving simultaneously with the roller, but only one-fifth as far. If a line is traced on the plate at the angle of 45 degrees the large wheel E would rotate at the same ratio as the movement made on the cradle C.

The spindle L, on which the discs are placed (and on which the balance arms M are also fixed), is carried out on each side beyond

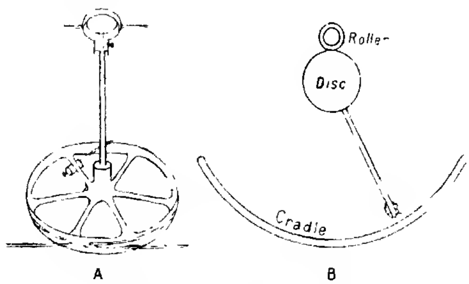

Fig. 101.—A shows reducing action for crossover; B shows reducing action for circumference

the frame of the machine, and rests between a single and double pulley which rotates in a box, N, fixed in the frame of the machine.

The machine represented in fig. 100 is known as the double bar —*i.e.*, it has one bar or rail under the roller and one on the top. Levers can be set on each bar, if desired, and thus two repeats or sketches may be engraved on the roller with each tracing. The top bar O is made to work conjointly with the bottom bar P by a short rod connecting the two. A long rod from the bottom bar connects with the treadle Q which, when treaded, brings the levers into action from the touch bar R.

Adjusting the Equilibrium or Balance of the Machine.—When various circumferences and weights of rollers are placed in the machine it is important that they should be balanced to the centre of the cradle, and the ball arms M, which are fixed on each end of the disc spindle, are used for this purpose. One of these balls (left side of

machine) can be raised or lowered, and the arms turned a little to the right or left, so as to adjust the gravity of the carriage rail in the centre of the cradle.

Adjusting the Mandrel. At one end of the mandrel (which runs through the roller) is a button screw at the left-hand side, this must be adjusted very exactly to lie in the box S. If too tight it will cause a drag when tracing, and if too slack it will cause side play.

Adjusting the Travel of the Machine.—The cradle is movable, and can be raised a little to meet the travel of a repeat on a plate which has been made out too small by the sketchmaker, or lowered a little should the repeat be too large. This is accomplished by turning the rod T, which has a worm screw inside a tapered block U, on which the cradle rests. It will, however, be obvious that the adjusting powers here are limited, and only about ¼ inch on the circumference of the roller above or below normal can be obtained.

Packing the Plate.—To get over a difficulty on some occasions this procedure is adopted. The cradle, when at its limit, may still be showing the repeat a little long at the joinings. A piece of wood, the width of the plate and 4 or 5 inches across, is tapered down from a ¼ inch to a fine edge, and placed beneath the plate, which allows this portion to be contracted at a quicker ratio, and thus meets the joining correctly. Instead of the wood several pieces of zinc or card-board may be placed beneath the plate, the first being pushed furthest down and the other pieces less, with a view to taper off, and not show any sudden or noticeable distortion of the shapes. The side joinings sometimes require a small piece of zinc slipped beneath the plate at different points to assist any continuous line to join perfectly. This may be required owing to irregularities on the surface of the cradle, or some parts not properly joined on the plate.

Slashing the Engraving.—This is required when straight lines run across the roller (see fig. 70), so that the printer's "doctor" will not catch the line all at once and tear the edges away, thus giving a smeared printing. Before this appliance was introduced and patented about 1888, the sketchmaker was compelled to slash the work on the plate, which entailed extra labour, also on plate cutting where the reverse half of sketches had also to be engraved.

The amount of slash is always calculated on 36 inches, and is obtained as follows:—On each of the tracer arms the screws V are moved in opposite directions to half the amount of slash required, thus screwing the arms of the square, so that when the tracer carriage is moved across the roller there is a motion of the roller in the

circumference which gives the slash. When setting the levers across the roller they also follow this slash or angle line.

For a pattern composed principally of cross lines $2\frac{1}{2}$ inches is considered a maximum, for ordinary work $1\frac{1}{2}$ inches is sufficient; but for double-hem handkerchiefs it is not advisable to go more than 1 inch, because the greater the slash for this class of work it becomes more difficult when hemming to get the one-half of the hem to fold correctly to the other.

Reversing the Engraving on the Roller.—All engraving is executed on the roller reverse from the design, so that when printed it appears as the design. There are occasions when the engraving has to be reversed by the pentagrapher—*i.e.*, when the sketchmaker has reversed the tracing or photo-work on the plate or to complete the reverse half of a sketch. This reverse motion is obtained in a very simple manner, viz., by letting the driving band loose at the bottom of the tracer carriage and clipping it at the top, thus reversing the motion of the lever rails.

Reversing Travel of Top Bar from that of Bottom Bar.—There is a short rod with two pulleys between the top and bottom bar. The bottom pulley is turned half round, which reverses the short band, and thus reverses the motion of the bar.

Changing the Tracer Arms.—When the cradle machine is working narrow copper, say up to 44 inches wide (as shown on fig. 100), it will be observed that the bush of the tracer arms is fixed outside the discs. To convert or change these arms to suit long copper occupies about three-quarters of an hour, and is done as follows:—

Before placing the longer roller in the machine, the two bands connected to the small wheel F are loosened and the tracing band taken off and rolled up. Next, the two balance arms M are removed, then the screws at the arms of carriage rail and disc spindles are loosened and the disc spindle L lifted out, the tracer arms H removed, placing the right-hand part over to the left and the left to the right (without turning them round). The discs are next placed on, and the spindle placed back into the machine (taking care to place the groove in the proper position). Place in carriage rail and fix it temporarily until the arms are divided off equally on each side from centre of spindle, then tighten them up and place on the tracing bands. Notice that the bush of the arms are now turned well in (see fig. 102), thus allowing the discs to be moved well out to the frame of the machine. The pulleys of the tracer arms are still in the same position, which admits of the same tracing band being utilised. Recently there has been introduced a newer style of arms which obviates all

this labour, the discs alone requiring to be turned, while the arms of the machine are always in position for long or short copper. An example of this machine, which can also be worked at three or five diminutions, is shown on fig. 116.

Stentering Allowance.—It is customary in wide or split cloths, that are stentered or pulled out to about the grey width after printing, for the merchant to request that the print should appear like the original design on the finished goods. In that case the engraver resorts to what is termed "stentering allowance." The plates are prepared in the usual manner for garments, but the pentagrapher,

Fig 102.—Tracer Arms arranged for Wide Rollers

before commencing his work, takes out the small wheel F (fig. 100) and inserts a pulley $\frac{1}{8}$, $\frac{1}{16}$, or $\frac{1}{12}$ smaller in circumference as desired, which contracts the engraving the required amount across the roller.

In giving stentering allowance judgment requires to be exercised, otherwise the engraving on the finished impression will have a very contracted appearance, and fail to possess the fulness so much desired. In the case of the fine home trade designs it is better to allow $\frac{1}{12}$ or $\frac{1}{14}$, and thus strike a happy medium. For extra coarse work, printing on a low quality of cloth, and where the engravers' impressions are

not used by the merchant for the sale of goods, an eighth is sometimes required in order to show the finished print like the original design.

In connection with handkerchief work the following simple method is adopted by the sketchmaker when stentering allowance is requested. Suppose the engraving was required for two designs across the roller at 40 inches wide, the plan or "rough" would be arranged to work out at 44 inches—*i.e.*, one-tenth wider. The plates or tools would also be made out according to the plan, and instructions marked to allow one-tenth in the machine. The pentagrapher would insert the tenth contracting pulley, and thus place the engraving on the roller at 40 inches wide.

Squaring the Plate.—This is a point, the importance of which is apt to be overlooked. If the sketchmaker has been careless in raising his square it will give further trouble at this stage if the joinings of the pattern are close. On the wood cradle of the machine there runs across and around the centre a flat piece of brass indented flush with the surface. The plate is set out with lines in the centre forming a square. The pentagrapher uses these lines by setting the plate to correspond with the lines on the brass, and clips the plate with a steel band and clamp (see X, fig. 100), then tests the square by running the tracing point along the lines around and across. When correctly adjusted a few tacks are placed through the plate to give increased security.

Setting the Levers.—According to the number of repeats across the roller so are levers required with diamond points inserted in the holder. The pentagrapher or setter notes that the first diamond point is fixed at a convenient place on the lever rachet, then rests one arm of the lever on the V (narrow) rail, and the other arm on the pivot of a chair which is placed on the "chair" rail. The lever is then moved along to the starting point near the right-hand end of the roller, and there fixed to the rail; while placing the foot on the treadle (see fig. 100, Q) he traces a small cross, thus + (see fig. 103, A), with the tracing point at the right-hand side of the repeat line on the plate, which is accordingly transferred to the roller. The tracer carriage is then moved to the left-hand joining of the repeat, a small cross made in a similar manner (see B in same figure). This lever is then "corked up"—*i.e.*, a small piece of cork is placed underneath the screw which rests on the touch bar, thus placing the lever out of action, and prevents the diamond point from trailing on the surface of the roller. Lever No. 2 is set in a similar manner, only the diamond point requires to be adjusted to the second cross already made on

the roller, he then moves the tracer carriage across and makes another small cross and "corks up" lever No. 2. In this and subsequent levers set across the roller the diamond point will require to be adjusted "out or in" with the diamond key, also the lever "tapped" right or left until the cross catches exactly on the cross already mode. Lever No. 3 is then set, and so on right across the roller.

The levers are next adjusted by placing three ply of zinc on the

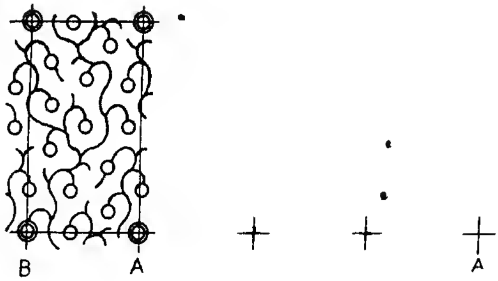

Fig 103.—Method of setting Levers

top of the screw, which is attached to the treadle support under the side of the machine. All diamond points are now placed on to the roller and zinc taken out, and screws tightened at the back of the levers which rest on the "touch" bar.

Levers for the top bar (if required) are set in a similar manner.

Weighing the Levers.—To get equal strength of engraving all the diamond points must scratch the roller uniformly. This all-important item is obtained by what is termed "weighing the levers,"

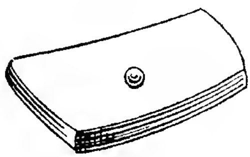

Fig 104.—Lever Weight

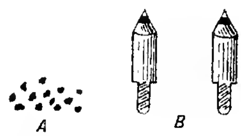

Fig 105.—A, Diamond chips; B, diamond chips set into holders and ground to a point

and is performed by placing a piece of lead, shaped as shown in fig. 104, usually abcut $2\frac{1}{2}$ ozs. in weight. The hole in the centre is placed over the diamond point, and the weight on the arm of the lever adjusted so as to balance, this method can only be adopted for bottom levers. For top and side levers a spring balance is hooked

on the lever near the diamond point, and the weight adjusted to register $2\frac{1}{2}$ ozs.

Before starting to trace, all the setting crosses are painted out and pitches arranged so as to be clear of any engraving (if possible) to be traced through them. When extremely close work requires to be placed on the roller it is a good plan to set the levers on a "spare" roller, and thus have a perfectly clean surface on which the engraving is to be done.

Diamond Points.—These are chips of diamonds that are too small for practical use in the jeweller's art. They are soldered with spelter into a small socket, and ground to a conical point (see fig. 105). There are various grades on the market, but the most suitable for engraving purposes are the Brazilian, usually sold from 6s. 6d. to 7s. each.

New diamond points sometimes give trouble in working from various causes.

1st. *Cutting too keen*, and, therefore, the engraving shows heavier in the sketches traced by these points. Usually the difficulty is overcome by marking them and giving the lever less weight.

2nd. *Dumb Points.*—So termed from the engraving appearing not quite so sharply cut through the varnish. Some of these points may etch all right, while others require to be marked and a little more weight added to the lever.

3rd. *Chipping.*—If the pentagrapher gives too severe a blow on the roller to mark a centre for pitches the point runs the risk of being chipped or broken. These points must be removed, and, if not too much shattered, they can be reground by the maker, and serve as good as new.

Levers, Close Set.—For the cradle pentagraph machine there are two kinds of levers, close and wide set. The more modern is the close set (see fig. 106), and are used on the narrow V rail. One of the "tongs" spreads well out, while the other "tong" rests on a pivot on the top of a narrow chair (see fig. 106), which is movable along the rail and tightened at the desired place by the thumb screw in the centre; the levers thus "bosom" into each other, hence they can be set at a distance of $\frac{3}{4}$ inch apart.

Levers, Wide Set.—These are adapted for back and front rail machines (see fig. 107), and are more suitable for handkerchief work. The chair is broader, and has a double pivot (see fig. 107, C) on which the lever rests. These chairs depend alone on their width to give steadiness to the lever, and are fixed on a broad flat rail, but, to occupy as little space as possible, the chairs "bosom" into each other. The levers can be set as close as $1\frac{1}{2}$ inches when desired.

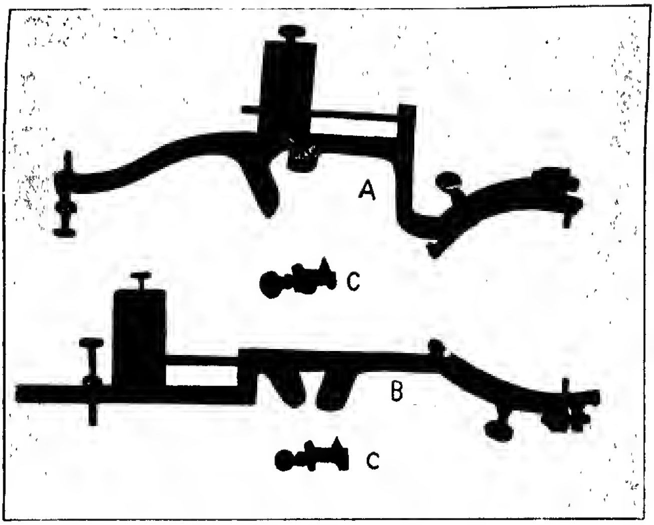

Fig. 106.—A, Lever close set for top rail; B, lever close set for bottom rail; C, lever chairs (close set)

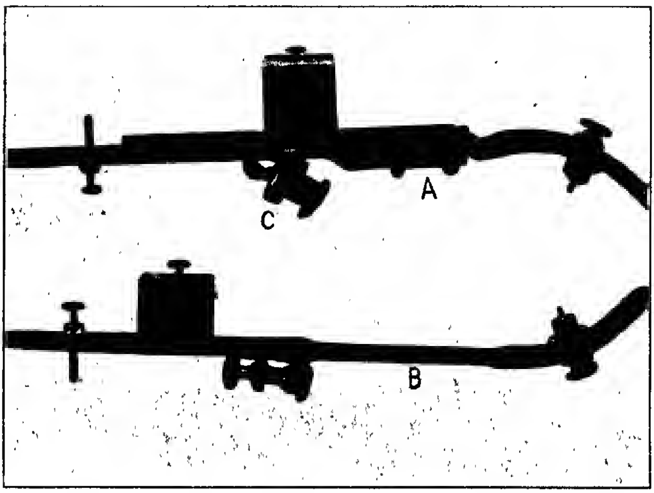

Fig 107—A, Lever, wide set, which can be adapted for top or bottom rail; B, lever, wide set, for bottom rail only; C, lever chair (wide set)

Overloading the Bars.—By arranging the close-set levers $\frac{3}{4}$ inch apart there would be about 46 set across a roller 36 inches long—*i.e.*, leaving the customary margin of 1 inch at each end of roller on which the discs rest, and, say, about 66 levers set across a roller 50 inches long. Owing to the great weight of all these levers it would be quite impracticable for working, and would cause a drag when tracing, which would give anything but good engraving. Judgment requires to be exercised here, and the point considered before preparing the tools, if it would not be more economical to engrave such a design by the mill, or place on two repeats on the zinc plate, and thus allow the pentagrapher to dispense with the closer set by using only about 23 levers for the narrow roller and some 33 for the wide one.

Method of Procedure for Pitching.—After the levers have been set and adjusted the operator places a centre at a convenient part of the plate, and terms this the "register." Placing the tracing point on this centre and holding it in position with the ball weight on top, he then turns the roller round and adjusts the pitching point W, fig. 100, to the first division line on the end of the roller, then tightens the screw on the disc at the left-hand side of the machine, which fixes it to the spindle on the body of the machine. Any movement now of the tracer arms around the cradle of the machine moves the roller. After tracing this sketch, the disc screw is loosened, the tracing point again placed on the register, the roller turned round, and the pitching point fixed to the second division line, and so on with each sketch around the roller.

If levers have been set top and bottom, or back and front, two sketches are accordingly engraved at one tracing, but should the pattern be an odd number of repeats in the circumference of the roller, say, seven repeats, three tracings would complete six sketches, the top levers would be dropped out of action and the odd sketch completed with another tracing. Before tracing the last double sketch it is necessary to try the joinings to see that they repeat perfectly; if not, they can be adjusted a little so as to avoid all the difference showing itself on the last sketch.

It must be understood that there is a roller for every colour, except when a superpose or fall-on effect is obtained from the same roller, which is fully explained under hand engraving.

Tracing.—On the tracer carriage, as mentioned under J in fig. 100, there are fixed the tracing and grounding points. The steel tracing point (see fig. 108, A) is fixed in a double wing-shaped holder, and held with the thumb and first finger of each hand when doing all

kinds of tracing. Previous to starting the tracing, the plate is rubbed over with chalk or flour, which fills up the engraving. As tracing proceeds, the chalk or flour is cleaned out of the engraved lines, which enables the operator to see when all the engraving is completed. This not only prevents any parts being omitted, but also prevents any line being traced twice.

The operator, while sitting on the stool (see fig. 100, W), places the point into the engraved line on the plate, and simultaneously places his foot on the treadle, thus putting the diamond points into action on the roller. At the end of the line he lifts his foot thus allowing the points to drop clear of the surface of the roller.

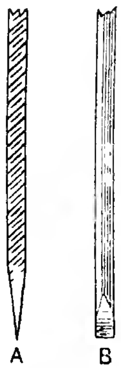

Fig 108.

A, Tracing point.
B, Grounding chisel.

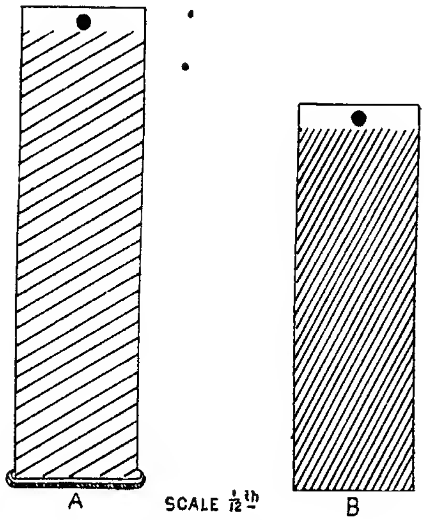

Fig 109

A, Ground plate for "cradle" pentagraph
B, Ground plate for "flat" pentagraph

Ground Plates (see fig. 109, A).—These are made of heavy zinc with parallel lines ruled on an angle and of various scales of lines from No. 8, which is equal to 40 lines to the inch when engraved on the roller. They rise in units (and are numbered accordingly) up to 32 for very fine grounds, being equal to 160 lines to the inch on the roller.

They are employed in the cradle and flat pentagraph machines for the purpose of obtaining " solids " or " shades," and thus give

uniformity of lines. The cradle plates are 9 inches broad by 32 inches long, and laid on the surface of the cradle at the right-hand side of the engraved plate. They are moved along the cradle and fixed with a clamp at the desired places.

For tracing "grounds" on the roller—*i.e.*, parallel lines to cover solid spaces—the chisel-shaped grounding point is used (see B, fig. 108). This is inserted into a small brass arm and fixed to the tracer carriage to the right of the tracing point, and held with the right hand. The chisel is placed into the line of the ground plate lying around the cradle. The tracing point is held with the left hand, and used as a guide only on the engraved plate for the start and finish of the ground line.

The importance of tracing must not be overlooked, because, unless it is skilfully accomplished, the engraving, when etched, will appear "ragged," and cause an immense amount of labour in dressing up

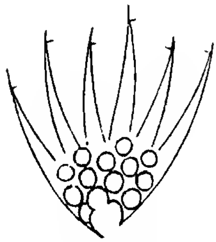

Fig 110 —Method of Tracing Tapered Points

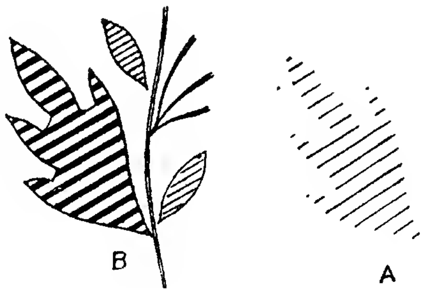

Fig. 111 —Tracings for Two Etchings

by hand to make it passable. The tracing point is pushed along the engraved line by the operator, and from the point of starting his foot must be placed on the treadle, but be released simultaneously with the finish of the line. In grounding he must start and stop slightly short of the outline.

When tracing tapered points the best results are obtained by tracing the short line first (see fig. 110), and finishing with the long line. If the reverse way be done it is sure to leave a mark where the short line stops.

For small rings or pins it is desirable to trace them twice, once round in one direction and then in the other. There is some art in tracing small rings to give a round shape. The operator must consider he is tracing a circle, and give the swing accordingly.

The apprentice, when beginning to trace, must proceed slowly, and, apart from learning to keep the tracing point properly sharpened, he must not press it into the engraved line; otherwise he will cause "ruts" which will give trouble when going through the engraving for the next repeat.

The tracing point must not be too sharp, which will readily stick in the engraved line, nor too flat, which is liable to cause slips, and create labour in going over the width of the roller to paint away these false marks; otherwise they would be etched, which would involve a greater amount of labour for the hand engraver in plugging them up.

Grounds and the Order of using Same.—When various scales of grounds are marked for the same roller, it follows, when all are to be completed on the pentagraph machine, that the coarsest must be used first and partly etched before the finer parts are placed on.

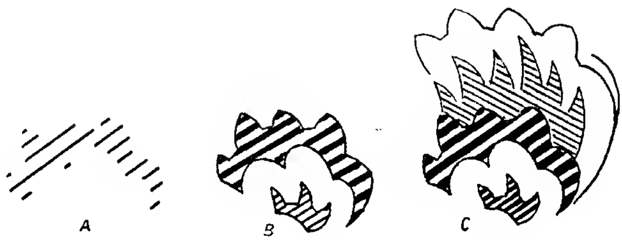

Fig. 112.—Tracings for Three Etchings.

Fig. 89 is a representation of an ordinary garment pattern, as explained in plate cutting. The large solids would be grounded with a No. 12 ground plate, which is equal to 60 lines to the inch when transferred to the roller. The operator would proceed to place this ground alone on every sketch around the roller (see fig. 111, A), which is then taken out of the machine, and part etched to about one-third solid, leaving two-thirds space between each line. The roller is now returned to the machine, and all fine parts of solids placed on with a 24 ground, equal to 120 lines to the inch on the roller. Outlines are also traced on every sketch (see B, same figure). Engraving being now complete, the roller is taken out of the machine and the mandrel removed. Previous to final etching the roller is examined for specks on the surface, which are touched with paint to prevent these false marks being etched.

For a fine garment pattern (as represented in fig. 112) a 15 ground plate, or 75 lines to the inch, would be used for the largest solids, and placed on the roller in the same manner as described in the previous figure. In this case it is assumed there is a superpose effect which is obtained by shade lines of the dark colour falling on a pale solid, therefore the part etch of this coarse ground requires to be kept further back, owing to the roller being placed three times in the acid before being completed. Usually one-fourth solid and three-fourths space between each line is sufficient (see fig. 112, A). The roller, on being returned to the machine, gets the fine parts of solids placed on with a 30 ground, equal to 150 lines to the inch. The outlines are also traced (see B, same figure). The roller is again taken out of the machine and placed in the acid, etching being continued until the coarse ground is about three-fourths completed. This will also have brought the fine ground and outlines up to about half the required strength. The roller is now returned to the machine for the third operation (see C, same figure)—viz., the shade or superpose effect, with a 17 ground plate equal to 85 lines to the inch. It is always advisable to place the superpose with a reverse angle ground, so that it will cross the ground of any pale solid when falling on it, and give a flatter effect. Engraving on the roller is now completed and the spindle removed. The surface is examined, as formerly explained, previous to the final etching being proceeded with.

Defects in Pentagraph Engraving.—There are various causes which may account for defects on rollers engraved in the pentagraph machine.

1st. *The Tracing Bands.*—If too tight the engraving will have a strained appearance caused by dragging. If too slack it will appear ragged, and also show short lines at joining points. The bands require to be adjusted or "tuned" in a manner which experience alone can tell best.

2nd. *Pivots* of the spindle, which rest on box wheels, may be *worn at one part,* and thus become oval, causing bad shaped rings. This will be specially noticeable when tracing small pins.

3rd. *Side Play* of roller mandrel, which is best detected by the lines in the circumference showing bad joinings; the button screw on the end of the spindle requires to be adjusted.

4th. *Levers carelessly weighed* will show irregular strengths in the engraving on various repeats across the roller.

5th. *Treading in a careless manner—i.e.*, not setting down and lifting the foot simultaneously with the tracing point. This will be

shown on the roller, especially by the ground lines being short and over the outlines.

6th. *Roller irregularly varnished or oversteamed,* which will incline the varnish to chip when tracing; or *understeamed,* which tends to clog the diamond points.

7th. *Machine requiring a good cleaning up.*—Oil may be clogged at some parts, and show irregularities of that sweetness in tracing which is so much to be desired. To use cheap oil is false economy; the best sperm is, therefore, recommended. The machine, being wrought by hand, is not able to create a friction caused by a

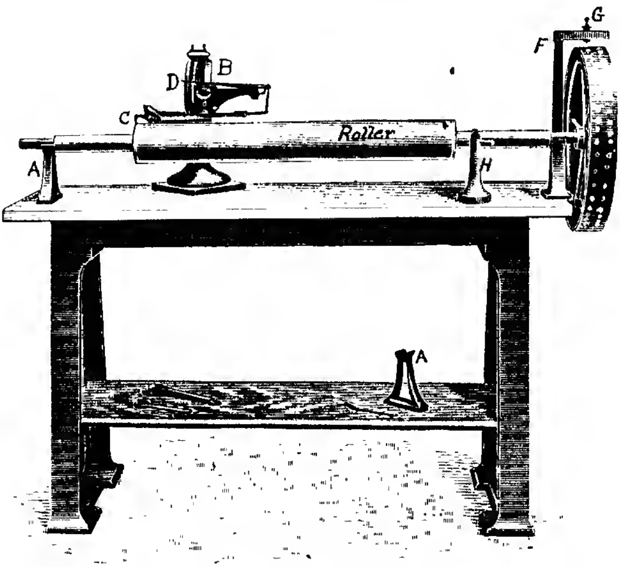

Fig. 113—Setting-out Apparatus.

quick motion which prevents a cheap class of oil from becoming clogged.

Setting-out Apparatus (see fig. 113).—The table or bench is constructed of iron, having a smooth surface for the purpose of being perfectly level, and is used for spindling rollers and marking divisions on the same previous to their being placed in the pentagraph machine. Rollers can also be set out, if desired, for hand engraving, there being a groove towards the edge along the length of the table in which the ruling fork can be securely placed when drawing lines.

Spindling Rollers.—After the surface of the roller has been covered

For a fine garment pattern (as represented in fig. 112) a 15 ground plate, or 75 lines to the inch, would be used for the largest solids, and placed on the roller in the same manner as described in the previous figure. In this case it is assumed there is a superpose effect which is obtained by shade lines of the dark colour falling on a pale solid, therefore the part etch of this coarse ground requires to be kept further back, owing to the roller being placed three times in the acid before being completed. Usually one-fourth solid and three-fourths space between each line is sufficient (see fig. 112, A). The roller, on being returned to the machine, gets the fine parts of solids placed on with a 30 ground, equal to 150 lines to the inch. The outlines are also traced (see B, same figure). The roller is again taken out of the machine and placed in the acid, etching being continued until the coarse ground is about three-fourths completed. This will also have brought the fine ground and outlines up to about half the required strength. The roller is now returned to the machine for the third operation (see C, same figure)—viz., the shade or superpose effect, with a 17 ground plate equal to 85 lines to the inch. It is always advisable to place the superpose with a reverse angle ground, so that it will cross the ground of any pale solid when falling on it, and give a flatter effect. Engraving on the roller is now completed and the spindle removed. The surface is examined, as formerly explained, previous to the final etching being proceeded with.

Defects in Pentagraph Engraving.—There are various causes which may account for defects on rollers engraved in the pentagraph machine.

1st. *The Tracing Bands.*—If too tight the engraving will have a strained appearance caused by dragging. If too slack it will appear ragged, and also show short lines at joining points. The bands require to be adjusted or "tuned" in a manner which experience alone can tell best.

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3rd. *Side Play* of roller mandrel, which is best detected by the lines in the circumference showing bad joinings; the button screw on the end of the spindle requires to be adjusted.

4th. *Levers carelessly weighed* will show irregular strengths in the engraving on various repeats across the roller.

5th. *Treading in a careless manner—i.e.*, not setting down and lifting the foot simultaneously with the tracing point. This will be

3 inches broad and 19 inches in diameter, with machine-drilled holes on the surface, so as to obtain any number of division lines from two upwards. The centre line is divided into 360, from which it will be observed that 2, 3, 4, 5, 6, 8, 9, 10, 12, 15, 18, 20, 30, 36, and 40 sections can be obtained. The sections on the face of this wheel to the right of the centre line are divided into 29, 42, 28, 32, 26, and 44; and to the left, 46, 25, 34, 27, and 38: these being numbers which cannot be obtained from the 360 divisions on the centre line.

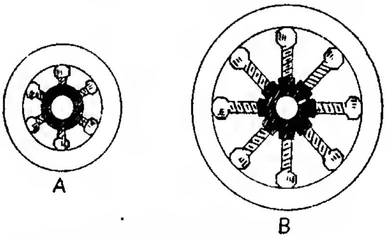


Fig 114.—A, setting hoop for rollers (garment bore); B, setting hoop for rollers (wide bore)

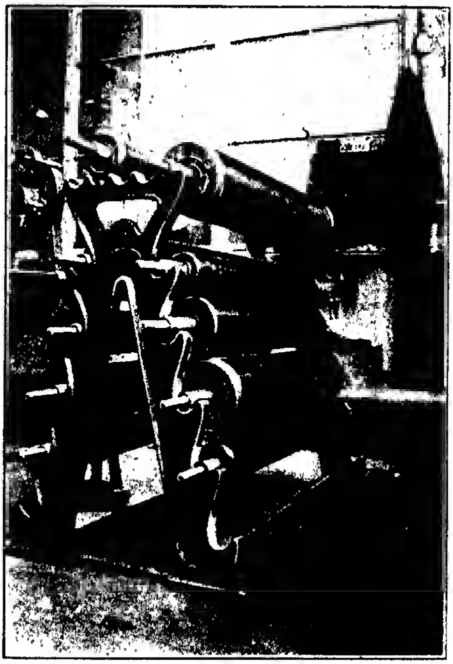


Fig. 115.—Mandrel Rack

Collars or Setting Hoops—Garment Rollers (see fig. 114, A).—These are required for fixing rollers on the spindles or mandrels, and

are constructed with a series of six screw pins to enable a true adjustment to be made with the centre of the spindle and the surface of the roller.

Owing to the mandrel being $1\frac{1}{2}$ inches in diameter and the bore of the roller $3\frac{1}{2}$ inches at the narrow end, it will be seen that there is a space of only 1 inch on each side between the mandrel and the inside of the roller to admit of the rim of the collar and pop for screw

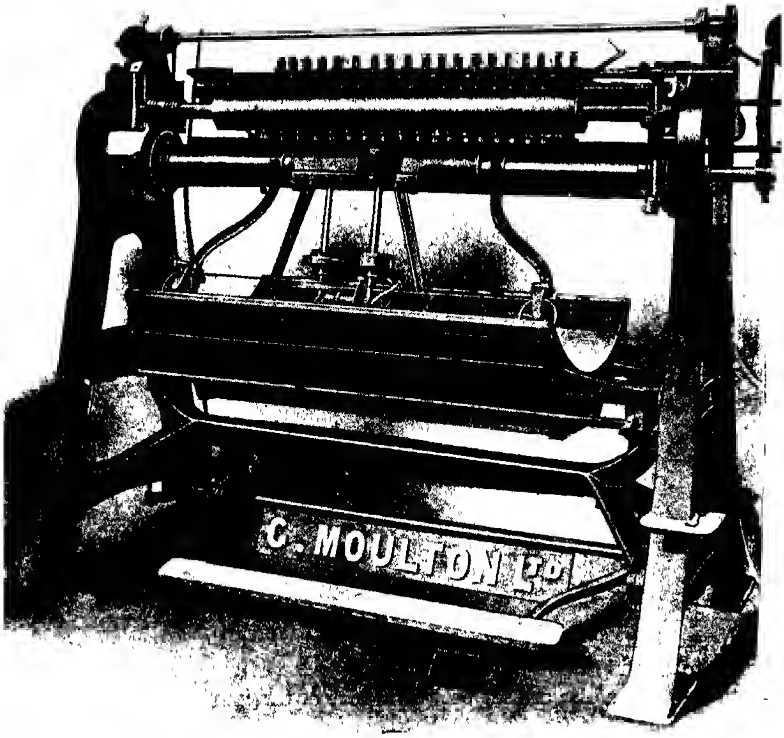


Fig 116.—Special Cradle Pentagraph Machine

pins, which necessitates short heads on the screws, the top of which are slightly rounded. At the wide end of the roller the pins can be a little longer. The collar has a space or saw draught between one of the six pops, this being required to allow a little spring when the pins are being tightened against the inside of the roller.

Collars or Setting Hoops—Handkerchief Rollers, various bores (see

fig. 114, B).—These are required for the same purposes as explained for garment bore, but owing to the variety of larger bores with solid copper more space is given between the mandrel and the inside of the roller. These collars are usually made with eight pops of a larger size. This also admits of longer screw pins to meet the largest bores. Where large handkerchief rollers are very thin and light, which sometimes gives difficulty in getting the roller to set true, two collars at

Fig 117 —Cradle Pentagraph Machines

each end can be used, the inner collar being set further inside the roller to admit of the outer collar being clear of the end. The pins of the outside collar are set between those of the inside one.

Mandrel Rack (see fig. 115).—This is a useful accessory in the pentagraph department for receiving rollers that are spindled and awaiting the machines, or rollers that may be partly engraved and requiring to be again placed in the machine.

CHAPTER VIII.

PENTAGRAPH ENGRAVING.

FLAT TABLE MACHINE.

(*Shields' Principle.*)

Construction and Working of the Machine.—The construction of this machine is named after the inventor, and known in the trade as the Shields' Principle (see fig. 118).

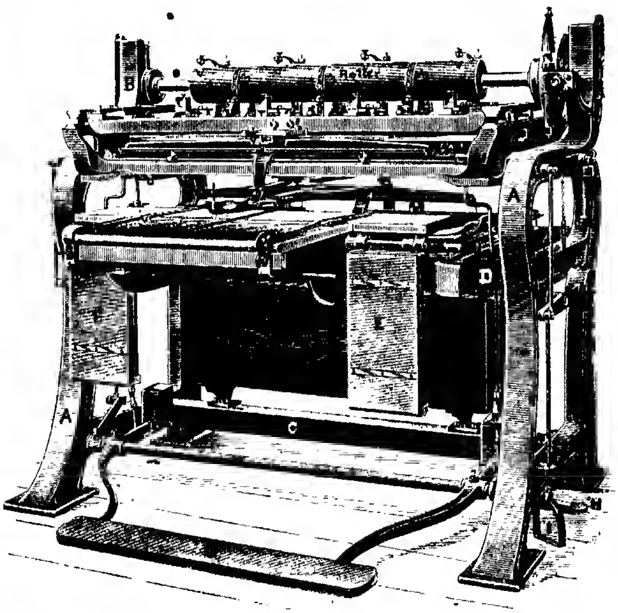


Fig 118.—New and Improved Flat Table Pentagraph Machine (Shields' principle).

The frame A is somewhat similar in construction to the cradle machine, only in the absence of the cradle less height is required, which is a decided advantage, as it allows of the artisan having greater freedom in setting levers and examining work from the back of the machine.

The jaws, B B, in which the mandrel rests are of similar construction to the cradle. The cross-iron beam C towards the bottom of the

frame, also the beams D on which the table is fixed, give the required stability for the steady working of the machine.

It will be observed that parts of the table E (9 inches on each side) are hinged, and can be dropped if required, which facilitates the setting and adjusting of the levers. The centre part of the table F is 26 inches wide.

The movements of this machine are contrary to that of the cradle, the motion being obtained from a double float, one working on the top of another, each on double travelling pulleys. The tracer arm moves in a socket, and when worked perpendicularly the levers move across the roller, and *vice versâ;* when moved across the table the roller revolves round.

After a study of the skeleton plan of the framework and reducing parts shown in fig. 119, the motion will be better understood. The top of the zinc plate is turned to the right-hand side and squared to the brass slips indented into the table, as in the cradle machine. When the engraving is transferred to the roller, what was across the plate (lying on the table) is engraved on the circumference of the roller, and the work on the perpendicular (or around the plate) is engraved across the roller.

The repeat of the design can be enlarged on to the zinc from two up to six times, and transferred on to the roller as the design. A plate prepared out of size can be contracted to suit the circumference of any roller, or stretched to suit a given width, or *vice versâ* if desired. It will thus be seen the facilities of this machine are vastly superior to that of the cradle, owing to the almost unlimited power of expansion or contraction. A safe plan to adopt, when the operator has his "travels" arranged, and previous to setting the levers, is to try a circle with a diamond point towards the end of the roller and ascertain if the proper proportions have been secured.

The extreme travel of the machine is $23\frac{1}{2}$ inches in width and $27\frac{1}{2}$ inches in length, which means that a repeat on a design about 8 inches broad and 9 inches in circumference can be arranged on a zinc at three enlargement.

The treadle G and the connecting-rod therefrom to the touch rail are manipulated in the manner explained for the cradle machine.

The touch action for diamond points can be tested by pressing the toe plate H.

To put the roller out of action for the purpose of examining the engraving, the foot is placed on the stirrup I and, while pressing, the iron wedge is slipped between the frame and the rod. Discs are now clear of the frame, and the roller can be turned round with freedom.

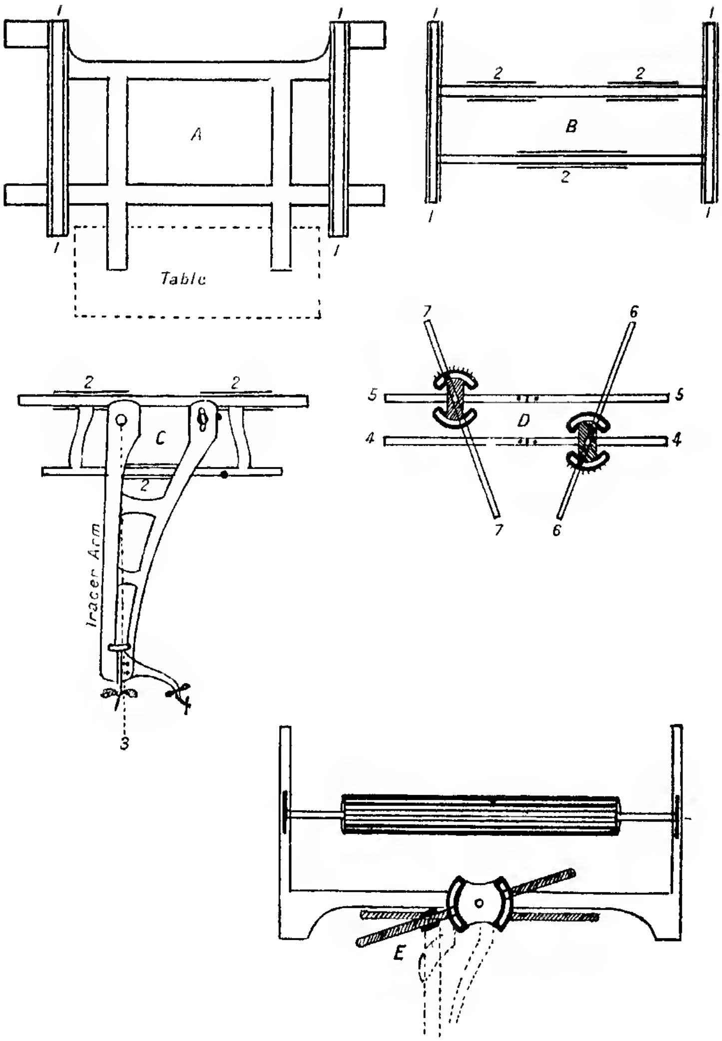


Fig 119

A Central framework fixed underneath to sides of machine

B, Frame floats top to bottom upon A, and moves lever rails right to left.

C, Frame floats right to left upon B, and moves frame E top to bottom, on this frame the roller discs rest To this frame is also attached the tracer arm, the dotted line (marked 3) indicates square and shows the tracer arm slashed

D, Reducing bars for cross over. To each bar is attached a slide (marked 6 and 7), so that when each bar (marked 4 and 5) is split, or opened out, square and reverse sketches can be engraved with the same tracing.

E, Reducing bars for circumference, which is attached to top frame Underneath the front of this large frame is fixed the small frame C

Clamps J are used for securing the plate; a few small tacks are placed through the plate to prevent any slipping taking place.

Adjusting the Travel.—The slides in front of the machine are used for adjusting the travel on the circumference of the roller. At five reduction the slides are very flat across, and are moved into a more perpendicular position as the reduction is required, down to two enlargement on the plate. The travel for the cross over is adjusted on the same principle from the slides under the lever bars from the back of the machine.

Slashing the Engraving.—The tracer arm is fitted with a slot and screw nut which can be moved off the square, as indicated on fig. 119, C,

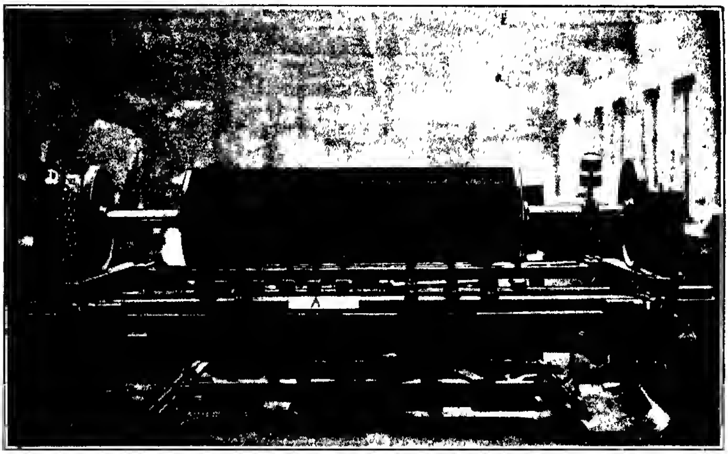


Fig. 120.—Flat Table Pentagraph (back view).—A indicates how lever bars are opened up or "split"; B B show the bars extending beyond frame of machine.

to give the required slash, thus enabling the plates to be engraved on the square.

Split Bars.—The lever bars on this machine are front and back, the roller being placed between them; each bar runs on four pulleys, and each is in two parts. When bars are coupled for ordinary all-over engraving a small plate is bolted to keep the two parts together, but if wanted "split," as shown in fig. 120, this small plate is removed and bars opened out, thus allowing the one-half to work reverse from the other, or the back bar to work a reverse motion from the front, if desired.

When working with split bars the couplings below the machine

must be attached to each bar, if the bar is not split one of the couplings is sufficient.

Opening-out Bars.—When the machine is working garment rollers, the bars are somewhat close to allow of the levers getting forward on the roller, and the small discs are placed on the spindle to allow the surface of the roller to come down close enough on the bottom levers. When handkerchief rollers are to be engraved the bars are opened out (back and front) sufficient to allow free movement of the levers across the roller. Larger discs require also to be placed on the spindle to raise the surface of the roller equal to the base of the garment. Any required adjustment between the sizes of the discs is overcome by the insertion of metal straps or blades about $\frac{1}{4}$ inch thick. These are screwed on the top frame on which the discs revolve.

Spindling the Roller.—The rollers are spindled, and collars inserted and trued with the micrometer on the same principle as for the cradle machine. The spindle has the same diameter as in the cradle machine, thus enabling collars to be interchanged, except for the extra wide machines, when it is desirable to have a heavier mandrel to prevent spring.

Division Wheel.—No division lines are required on the roller, as every machine has an index wheel (see fig. 120, D). The centre line on the face of the wheel is divided into 126 divisions, to the right hand 17, 23, 48, 27, and 22; to the left hand 19, 28, 25, 60, and 26; these being numbers which cannot be obtained from the divisions on the centre line.

Placing Rollers in the Machine.—The roller when being placed into the machine, first gets the disc placed on the spindle, then the index wheel at wide end, and, finally, mandrel slipped into box on frame after the same manner as the cradle.

Balance Arm.—It is often found that rollers when placed in the machine are unequally balanced. Especially is this the case with large electro rollers. To counteract this a balance arm or adjustable weight is fixed on the spindle at the light side (see fig. 120, C), which has the effect of adjusting the equilibrium and allowing the roller to revolve equally.

Levers.—In construction, the levers suitable for this machine are entirely different from those of the cradle, to suit the lever rails and touch bars. Instead of the levers resting on chairs they are fixed to the bars with a screw at the back of each lever, and a small wheel runs on touch rail when the bars are moved by tracer arm. These levers can be set as close as $1\frac{3}{4}$ inches from point to point (fig. 121), which illustrates a setting of four sketches—top, bottom, back, and

front. The levers for back and front (or side levers) are interchangeable. The bottom levers are suitable for all classes of rollers, owing to the base being at the same level, as already explained. Pillar levers

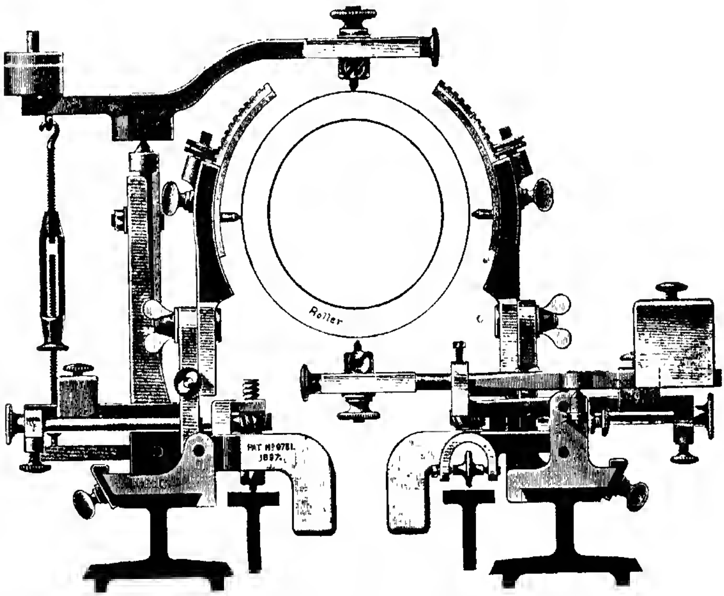


Fig. 121.—Levers for Flat Table Pentagraph Machine.

are used for the top, and, being of a telescope construction, can be adjusted to suit any circumference of roller.

Ground Plates.—Owing to the contrary working of the flat machine from that of the cradle the ground plates naturally require to have a different angle; for the cradle the lines run about 30 degrees (see fig. 109, A). For the flat machine they run about 55 degrees (see fig. 109, B), this angle being more convenient to the operator.

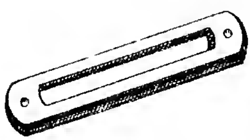


Fig. 122.—Bracket for Lever.

The manipulating of the flat table pentagraph requires greater care than in the case of the cradle, otherwise frequent mistakes and imperfect work will be the result. At the same time great facilities are obtainable for arranging levers, and, as a consequence, fewer tracings of sketches. Three, four, five, and six sketches can be set up on the round of the roller.

Where large corners of a handkerchief design are required to be

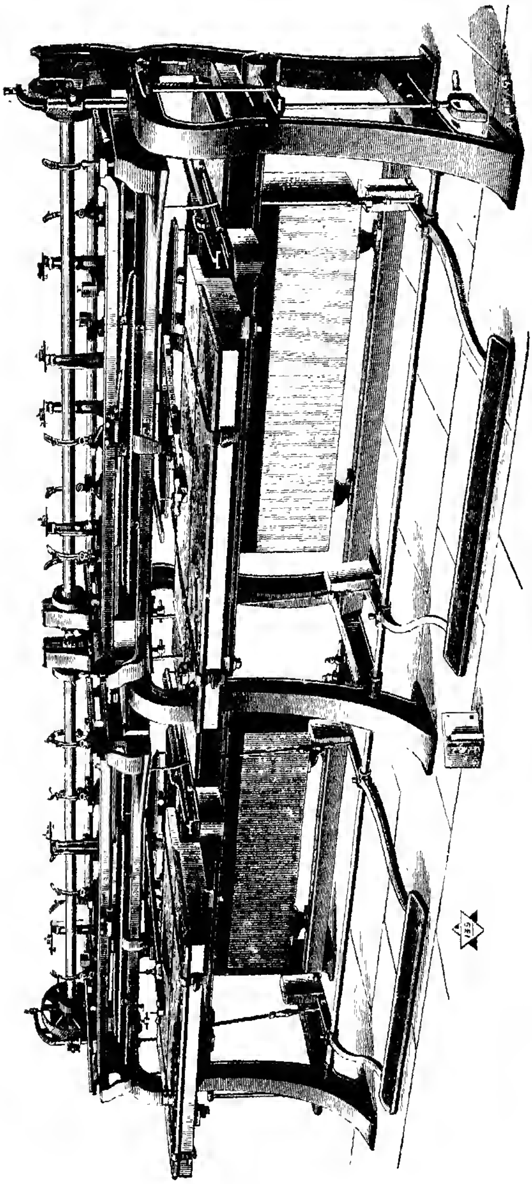


Fig. 123.—Improved Duplex Flat Table Pentagraph Engraving Machine (Shields' principle).

slashed, an ingenious method, adopted to save the tracing of the reverse corner, is to slash the bars the required amount, and set a lever on the back rail and one on the front rail. The machine is then worked on the square, at the same time giving the required slash, thus saving a tracing for the reverse corner.

Brackets.—These are brass slips about $\frac{1}{8}$ inch thick, $\frac{1}{2}$ inch broad, and 4, 6, and 9 inches long. Each of these are slotted, as shown in fig. 122. Both ends are bored with a small hole, and tapped to admit of a diamond point being inserted. They become most useful for both cradle and flat pentagraph machines, for screwing on to levers with a view to catching up any point not suitable with the lever alone,

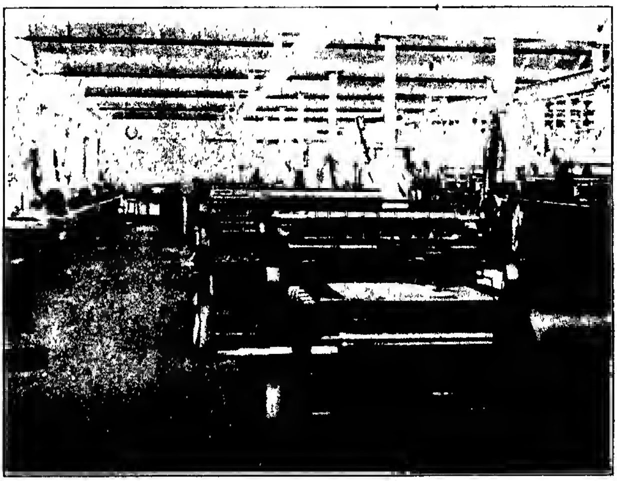


Fig. 124.—Flat Table Pentagraph Machines and Hand Engravers' Benches on Left

such as odd steps, or at the ends of rollers when the bars will not admit of the levers being set far enough out. They should be made of pliable brass, so that they can be bent to suit various positions or sizes of rollers.

Duplex Engraving.—When the cloth is printed with the same pattern on either side, and also fitted back to back, it is termed duplex printing. Two sets of rollers are required with similar engraving, therefore, with a view to economy, they are engraved in a machine specially constructed for this purpose, as represented in fig. 123. When engraving this class of design it is advisable to have the grounds a little finer than used for ordinary work.

CHAPTER IX.

DIE PENTAGRAPH MACHINE.

(Rigby Principle.)

Construction and Working of the Machine.—The die pentagraph or penta-die, an abbreviation well known in the trade, is the name for the modern method of transferring a repeat of the design to the die covered with varnish, and afterwards etching with acid in a similar manner to that accomplished in ordinary pentagraphing. Owing to the small size of the dies compared with rollers, a special machine, a miniature of the principle of the cradle pentagraph, has been constructed for this purpose, as shown in fig. 125.

The construction of this machine is only for five enlargement, but it enables the operator, to some extent, to adjust the repeat of the plate in accordance with the circumference of the die, by raising or lowering the cradle. Should the plate, however, be of a size beyond adjustment by means of the cradle, what is termed a "ring" is left on the die. This can be done in two ways (but the body of the die is always maintained the required circumference) :—1st. If the repeat on the plate requires to be reduced, a "ring" is turned on the end of the die smaller than the body, as shown in fig 126. 2nd. If enlarged, the "ring" is left larger than the body, as shown in fig. 127. The "ring" on the die is turned to the repeat of the plate, and always rests on the disc of the machine, thus contracting or stretching the engraving to join the circumference of the die during the operation of tracing.

It will be observed in fig. 125 that the die is gripped with an arm on each side, one of which is movable to suit various lengths of dies. An adjustable screw on each of the arms is fixed in the same centres of the die on which it was turned, thus securing a true movement of the body. One end of the die, that opposite the pivot, rests on the disc, which is five times smaller than the cradle, and a joint arm is brought over, the wheel of which rests on the body of the die for the purpose of preventing it from slipping.

The pressure of this arm on the die can be regulated by the weight

which moves along the slide on the top. The short lever rail admits of two or three levers being set if more than one repeat is required on the die.

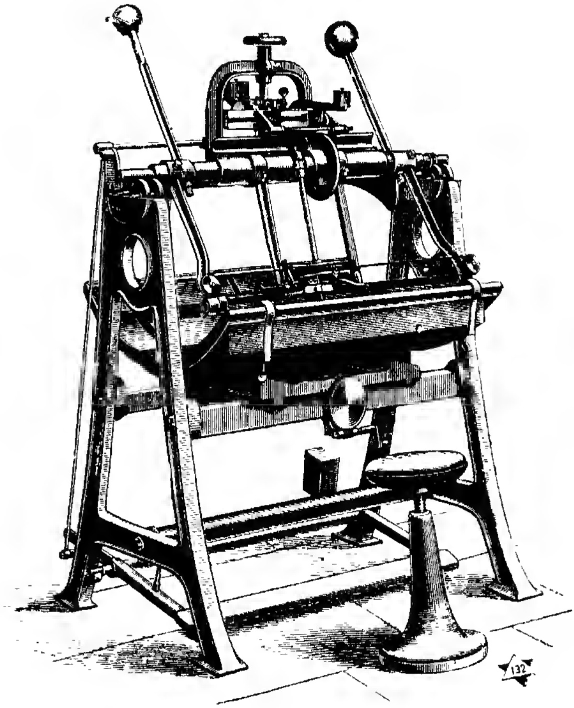


Fig 125—Die Pentagraph Cradle Machine (Rigby principle)

Squaring the Travel.—By occasionally testing the travel across the die to ascertain that it is on the same square as the mill engraving machine, much trouble is avoided where critical joinings prevail.

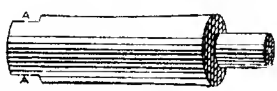


Fig. 126—Ring A A on Die smaller than Body

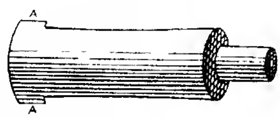


Fig 127—Ring A A on Die larger than Body.

This is done in a very simple manner by placing a diemaker's V on the surface of the die, and drawing a fine line across with a sharp point, then adjusting, if necessary, the arms of the die pentagraph to this line.

Three Enlargement for Penta-dies.—Where large repeats are essential for penta-die work it is good economy to enlarge the design three times, but if the machine is only suitable for five enlargement, they can be traced in the flat table pentagraph by having two arms slipped on the mandrel, and the die gripped as in the small die machine. The edge of the surface of the die is then run on the disc on the same principle as a roller.

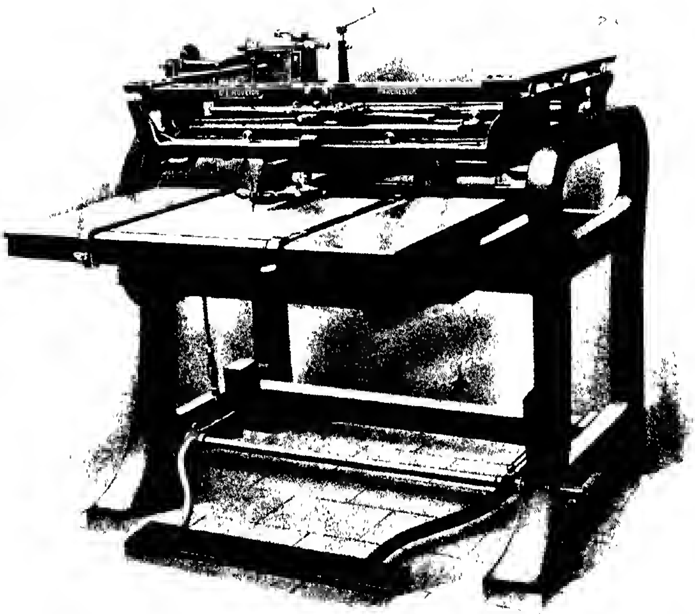


Fig 128.—Die Pentagraph Flat Table Machine (Shields' principle)

Flat Table Die Pentagraph Machine (see fig. 128).—This machine has recently been introduced by George Moulton, Ltd., and admits of dies being traced from two and a half up to five enlargement on the plate. It can accommodate dies 10 inches in circumference and 15 inches long, and, as in the case of the ordinary flat table machine, can enlarge or contract the repeat as desired. It should be noted

that where this machine is introduced the small cradle die machine is not required.

Varnishing Dies.—Previous to placing the die in the machine it is coated with a special varnish, either by dipping it in a vessel or covering it with a soft flat brush while in motion in the turning lathe. When dry it is ready for tracing.

Accuracy and Economy in Penta-die Work.—The penta-die process has two outstanding reasons why it is generally adopted.

1st. The facilities for accuracy which the enlargement on the plate provides, compared with the older method of drawing from the design and transferring the sketches to the die.

Even when the sketchmaker sets out the sketch in the most careful manner there is always the chance of the die being slightly smaller or larger in the circumference, from that of the sketch. All this variation, therefore, shows at the joinings, and, in certain cases, would require to be " faked " by the diemaker.

Again, there is the difficulty of transferring the flat piece of paper (especially with a large sketch) on a concave surface, and supposing the principal points of contact at joinings are set out with sectional lines, it is not so perfect as the method of enlarging on the plate and reducing by means of the machine. Further, the mechanical method of placing the grounds from the ground plates ensures their being perfectly level.

2nd. From the economical standpoint much could be said. The repeat can be photographed, or traced in the opaque camera direct to the plate, much more quickly than a die sketch could be drawn, and notwithstanding the little extra time occupied by the plate cutter, also in pentagraphing and etching the die, is time well spent when consideration is given to the advanced stage of the work when the die is etched ready for finishing off by the diemaker.

Allowances.—This is an important point which requires careful consideration, if the best results are to be obtained. As a rule, they are one-third smaller than for ordinary pentagraph work, not only because the engraving on the die does not swell so much in etching as it does on copper, but also because a finer class of work is being dealt with.

Tracing Dies.—This art need not be gone minutely into here, owing to it being performed as for ordinary pentagraph work, but in using the ground plates they are turned about to cross shapes as much as possible, so as to give better regularity (see fig. 129), instead of having the ground the same angle all over. This can be easily accomplished as only one repeat of the design is usually placed on the die.

Traverse Work.—When this class of work is done with the penta-die, the grounds must also be set out on the plate (see fig. 130). Great care must be exercised by the sketchmaker to have all the repeat shapes similar, otherwise the work will not traverse sweetly in machining. It is also advisable to have the ground set out right and left in small shapes as shown in the same figure, this method being a great advantage to the machine engraver when running spiral by giving a back grip to prevent the mill from slipping.

Snags for Traverse Work.—Sectional lines are imperative, and must be placed at each repeat, or even two division lines for more open work. They require to be accurately set out, and traced on the die about $\frac{1}{8}$ inch clear of the engraving on each side. The diemaker, when the engraving is finished, places a bold, pin centre on each of these intersections (as shown in figs. 130, A, and 189).

Etching Dies.—This being the foundation of success in penta-die work, the preparation of the acid is not only important, but also the temperature of the dies and of the workshop.

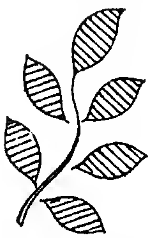


Fig 129.—Ground Lines tossed to suit position of Leaves

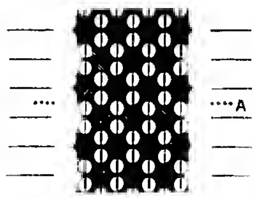


Fig 130.—Traverse Ground, "right and left."

To etch chilled dies in cold acid is to ensure failure. It is therefore advisable to see that the die and acid have a temperature of about 70° F. Should the workshop be cold, place the die on a slightly heated plate for a few minutes, and add a little warm water to the acid. Attention to these points will tend towards success.

Acids used for Etching Dies.—Nitric acid used alone on steel or mill iron will not give a good result; it is too harsh and severe on the grain of the metal, and will leave the etched line in a very ragged and unsatisfactory condition, but a mixture of acetic and nitric acids (four parts of the former to one of the latter), until it registers about 27° Twaddle, will produce a good result.

Stopping Out.—Much can be done during the process of etching by way of painting away fine points and pins at an early stage, and by continuing the etching a little further, and again painting out

medium parts and etching up the stronger parts as desired, thus saving considerable labour in finishing the die.

Part Etch.—Where much coarse ground is required, say 75 to 80 lines to an inch, the ground lines can be placed first on the die and taken out of the machine, given a light etch, and returned for the outlines and fine parts to be traced. The etch is thereafter completed.

A good plan is to trace at the side of the die part of a shape, also a small piece of ground. This can be tried during the process of etching, thus preserving the sketch intact.

When etching is finished the varnish is washed off with naphtha.

If the etching has been successful the diemaker only requires to clean through the ground with the graver to give the necessary sharpness. Even with the most perfect etch there is a certain amount of flatness which nothing but the graver will eliminate. For very fine work the ground must be on the surface with just a tendency to be slightly under it, so as to prevent any greyness when the roller has received the final polish. For ordinary work it is an advantage to be slightly under the surface, and for strong discharge work slightly more, thus obviating, to a great extent, unnecessary machining.

CHAPTER X.

TOOLS FOR CALICO ENGRAVERS.

Gravers.—These indispensable tools are used by the diemaker, the hand engraver, and the plate cutter, and their preparation is of the utmost importance. Too much stress cannot be laid on the " knack " of tempering, grinding, and whetting these tools to secure the best results. Gravers are small steel bars about $4\frac{1}{2}$ inches long with various curves to admit of the hand having freedom to work when the point of the tool is being used (see fig. 131). The medium curve is found to be the most suitable. They are hard when purchased, and then tempered to suit the various metals to be engraved—viz., steel, copper, and zinc. It is imperative that they should be of the best tool steel. They only cost a few pence each ; it is, therefore, false economy to have inferior material.

The majority of engravers break a small piece off the point of all new gravers before beginning to prepare them for working. By so doing, it serves the double purpose of giving a better idea of the requirements when tempering and also suits the diemaker's purpose, who usually works with a shorter graver than what is used on the copper. The plate cutter can, with advantage, utilise the full length owing to it being used on a flat surface.

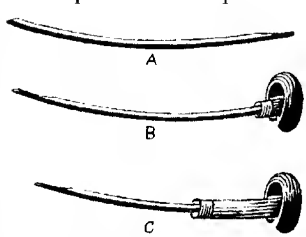


Fig 131 —A, Graver ; B, long graver in short handle ; C, short graver in long handle

Tempering the Graver.—A piece of fine emery cloth is laid on the bench, and the graver is held flat, and rubbed first on one side, then on the other, to polish the surface, care being taken not to injure the cutting edge. It is then gripped with pliers, dipped in oil, and drawn backward and forward through a small gas jet until it turns to the desired colour, then quickly immersed in cold water.

For diemakers (steel engraving) it is " let back " to a dark straw colour ; for hand engravers, cutting on copper, to a medium straw ;

and for plate cutters, who engrave on zinc which is a softer metal than copper or steel, to a light straw.

Grinding the Graver.—This is accomplished by fixing the graver in a small holder, and placing the face towards the point on the grindstone (see fig. 132). The grinding must not be overdone, especially

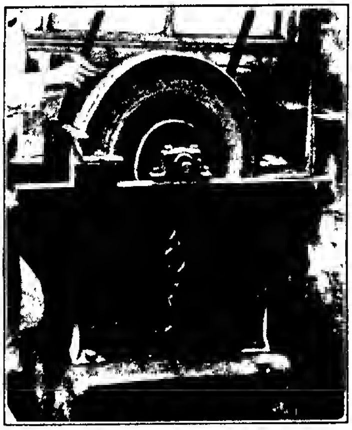


Fig 132 —Grinding the Graver

for the diemaker, or else it will have too much spring, and retard progress while working. They should also be ground from time to time, because a thick graver, when it loses the point, requires a great amount of whetting on the oilstone. Much time can, therefore, be saved by the frequent use of the grindstone.

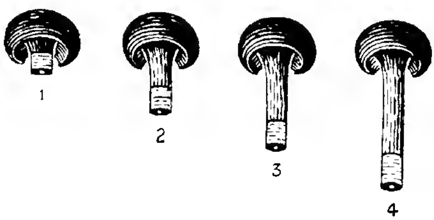


Fig 133.—Graver Handles.

Handles for the Gravers.—It will be observed from fig. 133 that the handle is mushroom shaped, and partly cut away to allow the rounded part to lie well in the palm of the hand. They are of various lengths, and numbered 1, 2, 3, and 4, No. 1 being the shortest and

suitable for new gravers. As the gravers become shorter with working, the longer handles are resorted to.

Setting the Graver in the Handle.—The adjusting of the graver in the handle sometimes does not receive the attention it deserves. A fine gimlet should be used first to bore a small hole, and an old "stump" of a graver heated to a bright red, and pressed into the hole (not bored). This gives a socket which will steady the graver. The handle will last longer and be a pleasure while working with it, but if the hole is carelessly bored into the handle it will cause the graver to "wobble," and give no end of trouble.

Whetting the Graver.—The process of whetting or sharpening the graver requires some practice to do it properly. The oilstone should first be cleaned, and a few drops of oil spread over the face. Take the graver in the right hand with the handle in the palm, supporting the graver towards the point with the thumb and first finger, at an angle of about 45°, and commence rubbing the graver up and down the stone. A practised hand will sharpen the graver in a few seconds. The operation of raising or lowering the angle of the hand to form new facets is termed "setting off" the graver, and is done to suit the class of work about to be engraved. If the point of a new graver breaks off, or is rubbed away rapidly on the stone, it does not necessarily prove that the tool is of bad material, as it sometimes happens that the graver has been overheated during the process of tempering. This may be remedied by retempering. If the point of the graver has been burned, ½ inch may be broken off by placing the graver in a vice, and, with a pair of pliers, sharply nipping off the end; but if still unsatisfactory it is better to discard the graver.

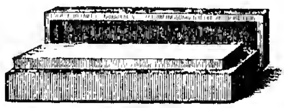


Fig. 134.—Oil Stone.

Oilstone (see fig. 134).—The oilstones used for sharpening gravers are, as a rule, of two kinds, viz., Turkey and Arkansas. The former is a soft and the latter a hard stone. The Turkey stone is good in its way if free from reeds, but requires constant refacing with a file, or on the side of a grindstone, to keep it level, whilst the Arkansas stone, although much dearer at first, will last a lifetime.

Gravers—*Single Point.*—These are of eight varieties, from No. 1 the sharpest, up to No. 8 the flattest (see fig. 135, A). From Nos. 1 to 4 are termed the "Lozenge," and from Nos. 5 to 8 the "Square."

Tooth Gravers—*Two Point* (see fig. 135, B).—These constitute an immense variety for engraving designs by hand. No. XXX is the finest, XX coarser, then X. They then open out into Nos. 0, 1, and

2, which, as explained under plate cutting, is the finest graver used on the zinc. The teeth open out as the numbers ascend in units, and are used up to about No. 10 for cutting grounds on the roller.

Three points start with No. 0 and graduate in the same manner as the two points, and have also the same scale of teeth, but only run up to about No. 8.

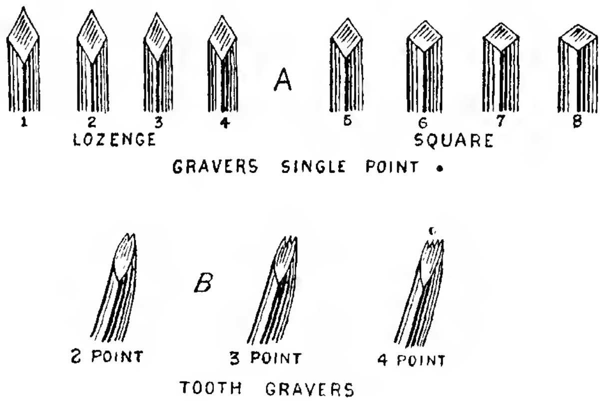


Fig 135.—A, single-point gravers. B, tooth gravers

Four-point gravers graduate likewise, but from this number of teeth and upwards they are called "rakes," and are used for running out certain widths of lines. No. 6 four point is usually the highest number used.

Five- and six-point gravers can also be purchased, but are seldom used.

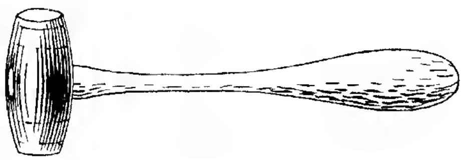


Fig 136.—Hammer

The Hammer.—This handy tool is used in all the departments: by the sketchmaker for placing holes in the plates when using the ruling machine; by the pentagrapher to secure the plate to the cradle and setting of levers; but especially by the diemaker, hand engraver, and plate cutter for all forms of punching. It is usually made a little ornamental on the sides, but this can be well dispensed with,

and a useful tool made barrel shaped, as shown in fig. 136. It must be of the best tool steel, and about $1\frac{3}{4}$ inches long by 1 inch in diameter at the centre, tapering off to about $\frac{5}{8}$ inch in diameter on each face, which is slightly rounded to prevent the surface of the roller being readily "clured" when using it. The hole, which is bored through the centre, must be tapered. The handle, about 9 inches long, is inserted at the narrow end of the hole, and a wedge is placed into the wide end for security. From the diagram it will be observed that there is a good taper towards the head, and that the part held in the hand is well rounded. It is customary for the hand engraver to have two hammers, one for mending, with a perfectly smooth face, and a heavier one for punching.

Fig 137 Mending Chisel

Hand Engraver's Outfit—Mending Chisels.—The smaller sizes of these useful little tools are usually made from "stumps" of gravers—*i.e.*, after they have become too short for engraving. They should be from $2\frac{1}{4}$ to $2\frac{1}{2}$ inches long, and the face, ground up to an edge, about $\frac{1}{16}$ inch broad. The larger chisels are made from punch steel, from $\frac{1}{8}$ to $\frac{1}{4}$ inch square. The largest should not exceed $\frac{1}{4}$ inch across the face (see fig 137).

These chisels are used for mending—*i.e.*, filling holes on the surface of the roller.

Burnisher (see fig. 138).—This tool is best and handiest made from an old three-cornered file about 9 inches long. Each side is ground, polished, and well buffed. The corners are also slightly rounded, and the point turned up a little. It is used for flattening

Fig 138—Burnisher.

down large mends and erasing scratches from the surface of the roller, also for rubbing large transfer impressions.

Germiniser.—This is a punch shaped exactly like a large mending chisel, but with a rounded face instead of the sharp cutting edge. Its use is to restore the top of a ground when small parts have got broken in the acid, or bruised in other ways.

Wire Card (see fig. 139).—The face of the wire is used for cleaning out dirt from the engraving, and is also useful for giving grounds a rub that have turned out a little rough when dragged. The back

of the card is also utilised for rubbing small wax-paper transfers on the surface of the rollers.

File.—A very fine cut flat file, about 6 inches long, is used for reducing large mends to the surface of the roller.

Straight Edge.—Usually a thin or supple steel straight edge, about 9 inches long, is included in a hand engraver's outfit. It is handy for lying flat on the circumference of the roller to rule straight lines.

Oil Rubber (see fig. 140).—This is used for the purpose of rubbing across grounds to show to advantage the parts that require "picking."

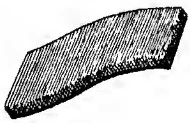


Fig 139.—Wire Card.

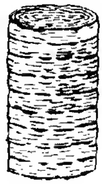


Fig 140.—Oil Rubber.

It is made in a roll from a strip of printer's blanket, about 4 inches broad, and rolled up extremely tight until it is about $2\frac{1}{2}$ inches in diameter, then wound round with twine, and the face dipped in oil and lamp-black.

Wire Reel (see fig. 141).—This simple but indispensable accessory is made from a round piece of wood about 9 inches long. Some six notches are cut out equidistant, and on these are wound various sizes of copper wire, which are used for mending purposes.

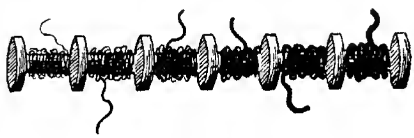


Fig 141.—Wire Reel.

Pins, Single.—A good assortment of single pins made from round steel are most useful, and a die, with, say, 12 of a graduation, should be in the hands of all good tradesmen. They are risen in the same manner as explained under punch making.

If a die cannot be secured the steel must be carefully filed to a point in the centre of the face, and with a long taper, the pin whetter is used to put on the points. In the absence of a pin whetter, very good points can be put on single pins by holding the pin between

the thumb and forefinger of the right hand, and, while revolving the pin, drawing the hand from left to right on the oil stone. Single pins should be hardened only; do not "let them back." They are the only punches treated in this way. They are graduated from a sharp point down to a thimble shape, and are used to tap through various sizes and depths of pins on the roller.

Pin Whetter (see fig. 142).—This is a kind of drill, and used in a horizontal manner with a string bow for the purpose of putting

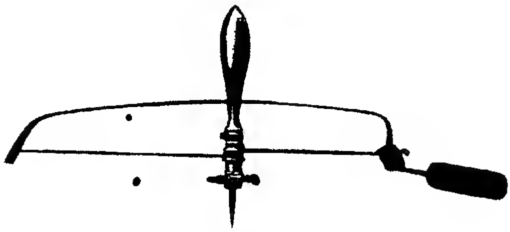


Fig. 142. Pin Whetter.

true faces on pin punches. When using this whetter great care must be taken to see that the pin is set true, and held steadily at the desired angle on the oil stone when working the bow.

Drag (see fig. 143).—This tool is especially constructed to give power for drawing the graver through grounds for the purpose of deepening the line to hold more colour when printing.

Traverse Pins (see fig. 144).—These are punches having two-pin points raised in relief on the face of the punch. They are moved one

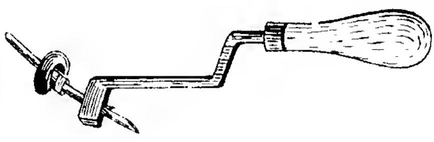


Fig. 143.—Drag.

point with each stroke of the hammer, thus giving equal spaces between each pin. This class of punch is generally used for defining shapes, as illustrated in fig. 145.

Hand Vice.—This mechanical tool is handy for the engraver by way of holding a graver for tempering or softening and redressing any punches on his own account.

Apart from these tools, which might be termed the indispensables

for a hand engraver, although they are far from constituting a complete outfit, he ought, in addition, to secure, as far as possible, a collection of stipple punches with 10, 7, and 6 pins on the face; a set of small rings and spots, they being most useful in touching up pentagraph work; also a set of seed and leaf shapes. The shop punches, as detailed under that heading, should always be used for new work.

Shop Punches and Accessories.—Every well-equipped engraving shop ought to possess the following tools. They should also be kept in good order by touching up or renewal from time to time. If placed in separate strong tin boxes they are handy for moving about as

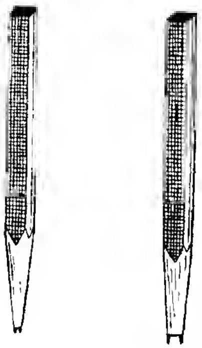


Fig. 144.—Traverse Pin Punches.

Fig. 145.—Leaf Shapes defined with Traverse Pin Punches.

required, and less liable to go astray. Diagrams of punches will be seen under punchmaking:—

One set of small single rings.
,, large ,,
,, No. 0 thick-edged rings.
,, ,, 1 ,,
,, ,, 2 ,,
,, ,, 3 ,,
,, squares (solid).
,, ,, (skeleton).
,, Oval shapes (solid).
,, ,, (skeleton).
,, small spots.
,, large ,,
small traverse pins.
,, large ,,

the thumb and forefinger of the right hand, and, while revolving the pin, drawing the hand from left to right on the oil stone. Single pins should be hardened only; do not "let them back." They are the only punches treated in this way. They are graduated from a sharp point down to a thimble shape, and are used to tap through various sizes and depths of pins on the roller.

Pin Whetter (see fig. 142).—This is a kind of drill, and used in a horizontal manner with a string bow for the purpose of putting

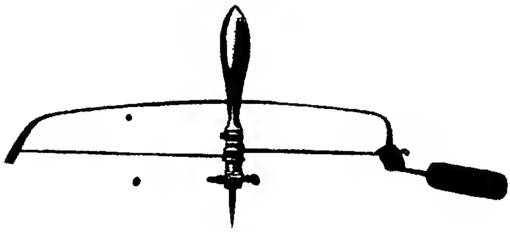


Fig. 142. Pin Whetter.

true faces on pin punches. When using this whetter great care must be taken to see that the pin is set true, and held steadily at the desired angle on the oil stone when working the bow.

Drag (see fig. 143).—This tool is especially constructed to give power for drawing the graver through grounds for the purpose of deepening the line to hold more colour when printing.

Traverse Pins (see fig. 144).—These are punches having two-pin points raised in relief on the face of the punch. They are moved one

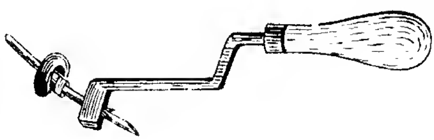


Fig. 143.—Drag.

point with each stroke of the hammer, thus giving equal spaces between each pin. This class of punch is generally used for defining shapes, as illustrated in fig. 145.

Hand Vice.—This mechanical tool is handy for the engraver by way of holding a graver for tempering or softening and redressing any punches on his own account.

Apart from these tools, which might be termed the indispensables

handle of the tool is gripped by both hands and pressed into the engraved line and rolled as required.

Roller steps (see fig. 148). These are made of cast iron, and are

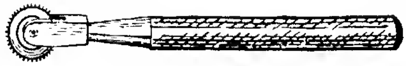


Fig. 147 Knurling Tool

box shaped, about 12 inches long and 4 inches square. There are four journals, two 3 inches and two 5 inches apart. Into either of these journals (according to the size of the roller) are inserted

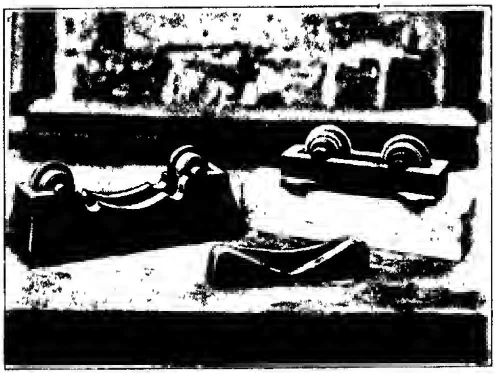


Fig. 148.—Roller Steps, various patterns.

two iron wheels with a shoulder on the outside, which prevents the roller from slipping. The roller rests on the base of the wheels, and can be easily revolved when setting out.

CHAPTER XI.

ELEMENTARY HINTS FOR HAND ENGRAVERS.

Drawing. For hand engraving as well as sketchmaking it is necessary (if success is to be obtained) that the apprentice should be a good freehand drawer, and ought to devote at home, or in a school, a great amount of time in developing the three movements towards acquiring this art—viz., those of the fingers, the wrist, and the arm. The first aim in drawing anything in line is to grasp the general truth of form,

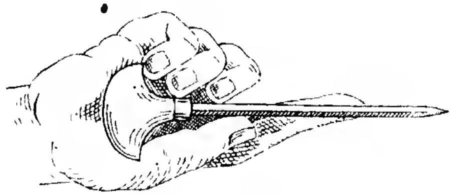


Fig 149 How to hold the Graver

character, and expression. The chief object is to establish an intimate correspondence between eye and hand, so that the latter will record what the former perceives.

When beginning to engrave, the student should learn how to hold the graver (see fig. 149), and try engraving a series of straight and

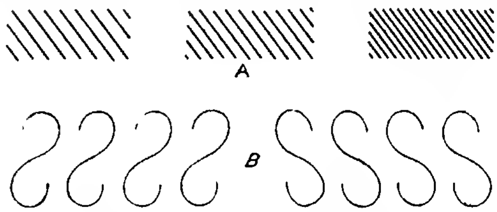


Fig 150—A, Straight lines; B, Curves

curved lines (see fig. 150) with a No. 6 single-point graver, before attempting ornamental or floral work. This can be done with advantage on a spare roller.

An engraved line is, and ought to be recognised as, nobler than a pen or pencil line, because it is more difficult to execute. The main

use of the restraint, which makes the line difficult to cut, is to give time and motive for deliberation in cutting it; therefore, caution and care are the first essentials towards progress.

Manipulating the Graver.—As the apprentice gains a little experience in "grounding," and becomes better able to handle the graver in "picking," he will then be able to do simple outlining, previous to taking up more intricate work, as it is necessary to be able to cut from left to right, as well as from right to left.

The constant inclination of the graver to slip out of the cut, making a line run off into space, will trouble the beginner. The graver belly is a curved line, convex towards the surface of the roller, and if the hand which drives the graver is lowered it instantly throws the point upwards, and a slip consequently ensues. If the reverse motion takes place, and the hand is raised a little too high, the point

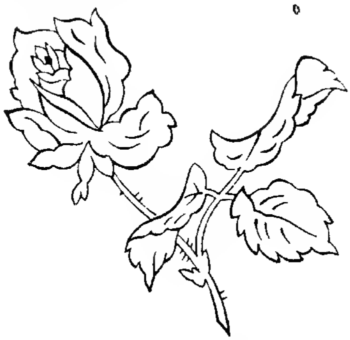


Fig. 151.—"Swelled" Effects.

at once "digs in," and the result is either a cut stronger than was intended, or the graver comes to a dead stop. Practice alone will give the necessary sense of touch and muscular control over the graver, enabling an even line to be cut by maintaining an equal elevation of the hand.

In cutting curved lines it is important to observe which side of the cut is perpendicular, and which inclined, because, in making the curve the handle of the graver describes a large circle, the point being a constant fulcrum, and the moment the body of the graver deviates from following the point in a straight line the belly of the tool has a tendency to touch one of the edges of the groove already cut. The graver must always be rolled over towards the convex side of a curved line, as in that position an incline is smoothly cut by the face of the graver which allows the belly to come out without touching the corner.

This peculiar motion of the graver, producing a cut of a varied width according to the rolling over, is of constant service in cutting swelled effects (see fig. 151) in a manner not accomplished by other means.

Again, in making short cuts in line work, the graver is manipulated in a manner different to that when cutting a long continuous line. The method or knack of springing the graver forward when within a short distance of the stopping point is peculiar and effective, and is acquired only after considerable practice.

Points worth attending to.—Always cut the leading outlines first, because other lines cut from, or into, these make better work (example, fig. 152, A).

Pointing as at B (see same figure). A point should be made by two cuts of the graver. Always cut shapes from the sharpest point—cutting to sharpest points tends to give clumsy finish, although expert workmen can cut satisfactorily either way. In cutting shapes from

Fig. 152.—Illustration for cutting Leading Outlines

Fig. 153.—Illustration for cutting Sharp Points

points always cut outside of shapes first (as shown in fig. 153, A); this gives a neater point and is much speedier.

When sharpening teeth gravers, be careful to square the teeth with the graver, otherwise an uneven cut will be the result, and necessitate going through the work a second time, thus adding a considerable and unnecessary time to the job.

When a curve is too much to overtake in one sweep be careful when again entering the graver not to raise the hand—the cut at the first stop being full strength—a knot will be the result, and the sweetness of the line marred.

Never take two cuts for a line, put the desired strength in with one cut. Hold the graver firmly and make up your mind decisively what you are about to do—and do it—no matter what breadth of line.

Holding the Punch.—A punch should be held between the thumb

and forefinger of the left hand, and allowed to rest against the second finger, while the third and fourth fingers rest on the roller or die to support the hand. The fingers should be kept well back from the point of the punch, so as not to interfere with the light. All punching should be done first, as cutting sometimes connects with punch shapes, this saves dressing up, which would certainly be the case if punches were put in afterwards.

When chiselling, do not let the chisel wobble in the hand; endeavour, as much as possible, to be like a machine when using punches of any kind, thereby getting uniform depth and regularity.

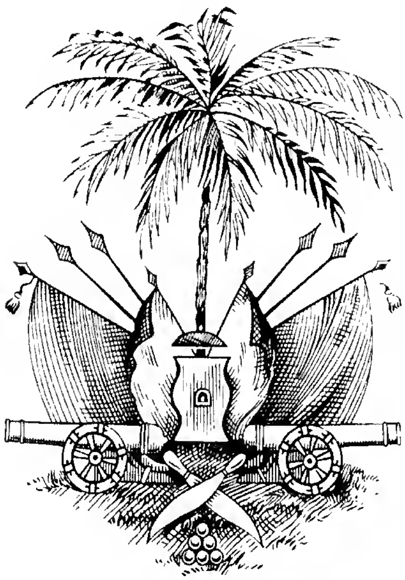


Fig. 154.—Light and Shade Effect from Lines.

Fig. 155. Figure, showing effect with few lines.

In using pin rings always retain the same catch of punch.

When mending small holes, use a small chisel, never a sharp pin. Also several short pieces of copper wire for large holes, rather than one large piece.

For "stugging up," use a round belly graver.

In burnishing any parts of engraving that are too strong, or parts that have been painted and roller got a run in acid for a "sink," be careful to burnish only the parts to be remedied, because the

burnisher easily "sinks" edges of the work, and it is most difficult to make it again right.

Holding the Hammer.—It is of the utmost importance that the learner should acquire a good style in holding the hammer, and give a graceful swing from the wrist, without raising the arm (except when making heavy punches). The handle of the hammer is held in the palm of the right hand, with thumb and first finger stretched out; the second, third, and fourth fingers being folded with ease around the handle.

Light and Shade from Lines.—It is surprising how many degrees of light and shade can be suggested by so simple a means as black lines on a white ground. True, there is no such thing as "tone," every part being either black or white, yet it is possible to suggest every gradation of tonal relationship of colours by this simple means (see fig. 154).

Figure Work.—In figure work some artists expend an enormous labour in filling up the whole drawing with multitudinous lines, others can obtain better effects with a few strokes and great expanse of white paper. In this style the principal study is to learn what to leave out (as shown in fig. 155).

It is well, therefore, that the engraver should learn how to draw figures before starting to engrave this class of work, which is, without doubt, the most difficult in his branch.

CHAPTER XII.

HAND ENGRAVING.

Reasons for Engraving a Design by Hand Method.—In considering the various details of hand engraving the question might be asked, "Why engrave a design by the hand method?" The answer is, because the large repeat or absence of repeat across the roller would render it unprofitable to do it by pentagraph, and impracticable by mill. It is, therefore, from an economic point of view that such designs are engraved by hand.

Various Sketches or Guides.—There are four varieties of sketches or guides applicable for hand engraving:

1st. Transparent oil paper.	3rd. Lithographic transfer.
2nd. French tracing paper.	4th. Photography.

They are each best suited to certain classes of designs, and, therefore, require to be treated in separate ways.

Oil-paper Sketch.—This is the most transparent, and perhaps the oldest method in the trade for giving guides for the hand engraver, and is still the most useful medium for the sketchmaker where alterations from the design are required, and, further, it can stand a fair amount of handling while transferring the first colour to the roller and still retain its transparency for the subsequent drawing of the other colours, thus saving hair lining by the engraver. If serious contraction or expansion is required it is advisable that the sketchmaker should, after setting off the repeat on the oil paper with a fine steel draw point, sectionalise the repeat into six or eight divisions, and also do likewise with a light pencil line on the design. This will materially assist the blocking out, which should also be repeated at the joining previous to proceeding with the sketch.

The sketchmaker first rubs the surface of the oil paper with a little water and a touch of gall to take away the greasiness and allow free working of colour. When using lamp black it must be of a good quality with just enough of liquid gum arabic added when mixing to allow a clear and sharp impression to be transferred to the roller. If too much gum is added it will harden the colour, and prevent it being

transferred. The sketch is drawn by means of a sable-hair brush of a size in accordance with the class of work about to be done. If for very fine work, a small brush is necessary; but for ordinary work, a good bold brush which points well and allows a free flow of colour will be found the most suitable for speed.

Cretonne Designs.—For a six- or eight-colour design of this class it is often advisable to draw all the colours at once, and, should it be complicated, the leading colour with black and all the others, say, with red. This plan enables the engraver to cut the leading colour the strength required, and hair line all the other colours without losing time in following the design too closely.

Curtain Designs.—For sketching a plain-going curtain design of, say, four colours, this can be accomplished by drawing the two leading colours with black, taking two transfers to the roller, and returning the sketch to get the other two colours drawn, thus saving the expense not only of hair lining, but also of erasing the hair lines from the roller when engraved.

French Tracing Paper.—This medium for sketches not being so transparent as oil paper is, therefore, not suitable where detail exists in designs with delicate shades. If alterations are necessary the erasion may be done with rubber or a little turpentine. The tracing is done with a lead pencil, which gives a good transfer on the surface of the roller, but the surface of the paper is much dulled in the process of transferring, therefore this class of sketch is most suitable for one-colour patterns of a straight-going character.

Lithographic Transfer, or litho sketch, is very suitable for a garment design with many colours of the Japanese class. The sketchmaker draws all the colours, which can be done with a fine pen as well as with the brush. If the surface of the oil paper is hard, more speed can be obtained with the pen than with the brush. Paper made transparent with copal varnish is most suitable, giving a hard surface, and being less liable to be scratched with the pen. French tracing paper can also be used if the surface is sufficiently transparent.

The lithographic ink used for this purpose is mixed with water to a thin consistency, and must be laid on the paper in an equal manner, but not too thickly. The line must be drawn fine, as it has a tendency to flush a little when being transferred to the stone. Further, it does not require to show very black on the paper, as it is the grease alone in the ink which is transferred.

A small cross must be drawn at the intersections of the repeat lines as a guide for the engraver when setting out the transfer to the rollers. When the sketch is finished it is advisable to forward

it to a lithographer who can make a better transfer with his press on to the specially prepared stone. An impression is taken from the stone on oil paper, according to the number of colours in the design.

Photographs.—It will be found in practical working that only a small proportion of hand designs are suitable for photography, owing to the difficulty of getting sufficient contrast of tone where there are many colours. Pictorial designs are most suitable, because although enlarged or reduced from the original, correct proportions and expression of feature are better retained.

The method of photography for hand engraving is fully explained under Chapter IV.

Setting Out Rollers.—Previous to transferring sketches or guides to the roller, they require to be "set out" with certain lines to enable them to be placed in correct position. A point worthy of consideration is to have as few lines as possible, and this for two reasons—1st, the saving of time and possibly confusion; 2nd, to avoid the erasing of needless lines afterwards.

The roller having been polished and cross scoured is set on the bench (number or wide end to left-hand side) upon wheel steps, these being pinned down to prevent any movement taking place. The point of the ruling fork is set at the centre of the roller, which is then turned round. A line across the roller, and forming a right angle to the round line, is next set out as follows:—

The feather (inside of all rollers) is recognised as the starting point, and turned towards the top, therefore on handkerchief designs this will decide the centre of the gaw. A convenient radius is fixed on a pair of dividers, and marked on either side of the centre; the larger the circumference of the roller, the larger is the radius taken. From each of the intersections the beam compasses are stretched across the roller, and a small arc described, the straight edge applied, and a line drawn across the roller. Lines for repeats or sections, as required, are marked on this cross line, and ruled with the fork, as shown in fig. 156.

Slash.—If the engraving requires to be "slashed," as shown in fig. 156, it should be attended to at this stage, as cross lines made subsequently must run parallel with the slash. If a slash is required it is a convenience to measure the amount from the sketch, but judgment as to the amount ought to be exercised, especially for handkerchief work, owing to "quarter" sketches requiring to be reversed or chased, thus throwing the work in the opposite angle, which will necessitate the patching up of the other quarter. It is,

therefore, advisable to "slash" as little as possible on this class of work.

For division lines in the circumference, a radius, in accordance with the size of the roller, must be taken and tried for equal divisions around the roller. Every second, third, or fourth section, as required, can then be marked off at the ends of the roller, and lines drawn across with a steel draw point.

For handkerchiefs, half the size of gaw is then marked off on each side, and ruled across. If the width of borders require to be set out, this should be taken from the sketch (as alterations may have been made from the designs), and marked off for round borders. This width is marked on a piece of paper, and laid around the roller, when it will be found that the radius of the dividers requires to be contracted. This is an important point, which must be attended to,

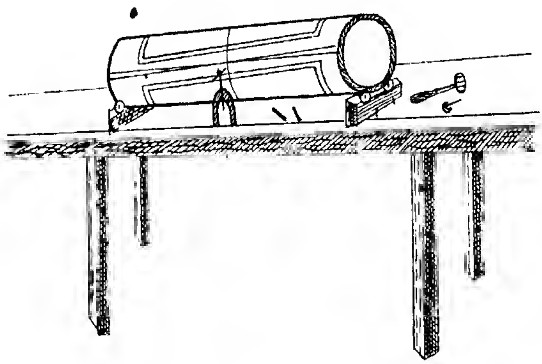


Fig. 156.—Method of setting out Roller for Hand Engraver.

owing to the great difference between measuring across and around the cylinder.

Sketch should now be placed on the roller to see that lines correspond.

Transferring Sketches.—The roller is coated evenly over with resin varnish, and allowed to set, become almost dry, and just slightly tacky. The sketch is then laid face downwards, and burnished lightly with the back of a wire card. If the colour on the sketch has been right, a good transfer will be obtained. This should be examined by raising a part, and, if unsatisfactory, more pressure may be applied with a piece of leather, but care must be taken to avoid "bagging" the paper. The roller is now ready for the engraver.

This method of transferring is suitable for oil and French tracing paper.

An unsatisfactory transfer may result from several causes—1st, roller not properly cleaned; 2nd, excess of gum in sketchmaker's colour, rendering it too hard; 3rd, too little resin varnish on the surface of the roller, or too wet when sketch was laid down.

Wax Impressions.—After the repeat or quarter sketch has been engraved, impressions are taken from the same in the following manner:—A little naphtha is first used to clean the surface, and powdered lamp-black rubbed into the engraving, and the surface of the roller cleaned with a soft leather pad, although the workman usually applies the side of his hand for this purpose.

A sheet of oil paper is next rubbed over with beeswax, which is well spread with a dolly rubber. The waxed side of the paper is laid on the roller, pressure and rubbing are resorted to with the wire card or burnisher, and the transfer pulled from the surface of the roller.

If a reverse impression is required, another piece of waxed paper is burnished on the top of the first impression, and the reverse transferred to the roller. When the engraving on this (the leading roller) is completed it is then polished to take away any "burr," and thus gives a clean surface.

Full Impression and Proof.—A piece of heavy cartridge paper is cut the width of the roller and about 2 inches larger than the circumference. The surface is waxed and well spread, and the engraving on the roller filled with lamp-black, as already explained. The waxed paper is laid on the roller and vigorously, but evenly, rubbed with the burnisher. The 2 inches of extra paper is also overlapped and burnished down. Three pitches, one in the centre and one towards each end of the roller, are cut, thus 4, on the centre of the lapped portion. The lapped portions are lifted up several inches, and the upper part laid on the surface of the roller and burnished well down, thus showing a repeat of the circumference. The paper is now gently pulled from the roller, and termed the "full" impression, which also serves as a proof for examination with a view to corrections if required.

Transferring Full Impressions.—Rollers for the other colours have already been prepared, because it is better not to allow "full" impressions to lie any length of time, as shrinkage may take place. The various rollers are covered evenly with resin varnish, and the impression laid around the roller, gently at first, to see that the pitches join exactly square on the circumference. It is then burnished on

the surface. Three transfers, with care, can be taken off, but if more are required it is advisable to arrange for a second impression.

The rollers for the various colours or "pegs" first have the parts engraved that bondage on the leading roller. The original sketch is then laid on, and a transfer taken from the parts required. An impression is now taken from the complete repeat and typed all over, fitting the transfer to the parts already engraved from the full impression, thus ensuring a perfect fit of the one colour to the other.

This system is repeated for all the pegs. Rollers are then polished, and forwarded for the ruling of shades or solids as required.

If any narrow lines (cross or round) are on the rollers, these require to be "run out" with a tooth graver, and milled, previous to the roller being polished, and forwarded for ruling of shades or solids.

Transferring Litho Impressions.—Rollers for these guides require to be treated in a different manner. The first roller is set out, as already explained, but at the intersections of the repeat lines a small cross or pitch, thus +, is cut with the graver (usually three of these are sufficient). These pitches are filled in with lamp-black, and a full wax impression taken from the roller in the manner already explained. This impression is then transferred to all the other rollers belonging to the pattern, and the pitches engraved the same as on the first roller. The first roller is now covered with resin varnish, and the litho impression transferred in the same manner as an oil-paper sketch.

Each of the litho impressions is carefully fitted on the top of this first transfer, and the small cross or pitch traced or marked with a draw point. This cross now becomes the vital point as regards fit for transferring all the impressions to the other rollers. It is obvious this method must be accomplished with care and accuracy to ensure all the colours fitting.

The engraver now sets to work and engraves only the parts required for the respective colours.

The litho sketch method is best adapted for extra large repeats, once round the roller and proportionately wide. It has only the advantage of saving a great amount of hair lining, proofing, and transferring.

Proving or Testing the Fit.—An impression embracing the two cross borders of a handkerchief is taken off on waxed transparent paper from the leading roller (usually the one binding on all the other colours at various points). The rollers to be tested are cleaned, and receive a light coating of resin varnish at the part to be tried. The proof impression is then laid on, and, if correct, should fit at

the required parts. This impression is also used for placing pitches on the rollers (for the purpose of taking cloth impressions from the finished engraving in colours corresponding to the design), and done as follows :—

Before removing the transparent paper from the roller, a pin point is marked at a convenient place, also a similar mark straight across, about 7 inches apart. These two points are likewise marked on all the other rollers when proof mark is fitted on.

Misfit is the term applied to any engraving where the one colour does not register or fit correctly with the other. This may occur on a single sketch, or several repeats comprising a border or filling, and may be caused by the pentagrapher "pitching" from a false register or centre, or through some mishap, such as getting a lever knocked off the pivot. Again, all the engraving of one roller may fail to fit, owing to it being slightly smaller or larger in the circumference from the others.

Fig. 157.—Figure showing very Fine Touches.

Suitable Gravers.—Regarding the most suitable gravers to use on certain classes of work, opinions must differ to some extent, because so much depends on the method to be employed in printing. One important point the engraver should always have in view is to regulate the strength of engraving in accordance with the "grounds." If the grounds are fine then the outline of the solids and other detail ought to be cut with fine gravers, and not too deep. If coarse grounds are used for solids, the outlines will then stand a coarser graver and detail accordingly. It must be noted that a deep line can be cut with a fine graver, and perhaps out of all proportion to the surrounding work. This is specially the case with a No. 1 single point; this graver requires to be carefully and skilfully handled. It is most suitable for fine touches in figure work (see fig. 157). No. 2 single point can also cut a very deceptive line for depth, and may carry too much colour in printing, but is very suitable for fine touches in floral work (see fig. 158) when used with judgment. Nos. 3 and 4 single points are much used gravers in ordinary work.

Two-point Gravers.—The finer two points are used for outlining solids, the XXX for the finer grounds and the XX for the coarser.

the X being more used for stems of flowers where a little " pith " is required. Nos. 1 and 2 can, with advantage, be used for coarser detail.

" Combing."—When large pieces of *ombrè* work have to be engraved, the outline is first engraved as shown in fig. 159, and afterwards

Fig 158.—Floral Work showing Fine Outlines

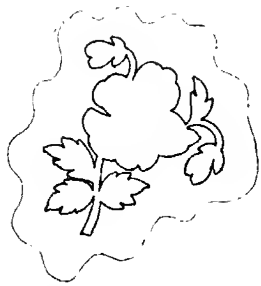


Fig 159 —Outline as Guide for " Combing "

" combed out," thus saving a vast amount of time in repeated stippling from the plain copper. Usually a No. 4 four-point graver is used, by gradually taking a deeper cut towards the heavy part of the *ombrè* effect (see fig. 160). Each of the sketches or repeats require to be done in a similar manner, so that when stippled on the top of the

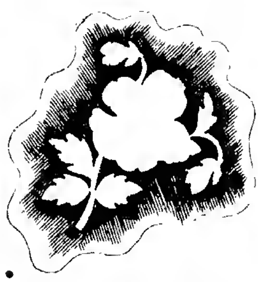


Fig. 160.—Combing previous to Stippling.

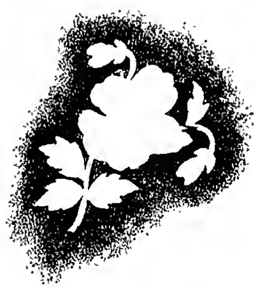


Fig 161 —Stippling

" combing " and roller afterwards polished, all repeats will appear a uniform strength.

Stippling.—This is done for the purpose of giving an *ombrè* effect or graduated shade (see fig. 161) from a very light touch into a solid. The engraver uses a stipple punch in accordance with the size or

construetion of the parts to be done, and with the aid of the hammer strikes the punch while he moves it, in what might be termed a regular irregular manner, thus placing a chattered pin effect on the parts required. The roller is then polished to take away the " burr " created by the stipple punch, which, on examination, will be found to have been very great, so much so, that the heavier parts of the stipple (notwithstanding the taking away of some of the eopper with the

Fig. 162.—Shaded Effect from Pins. Half scale

" combing ") are very light indeed. The heavier parts of the stipple are again gone through. This time it is an advantage to do so with a finer puneh. The roller is again polished, and will be seen to be much nearer the desired effcet. A final touehing up then ought to give satisfaction.

Pin Effects.—Beautiful shaded effects can be obtained from

pin work, especially where shaded effects are desired in handkerchief patterns, as shown in fig. 162, or flat effects, as shown in fig. 163.

This effect differs from *ombrè* work, owing to every pin standing out individually and showing a clear white around each. The size and strength of the pin obtains the shaded effect which can be wrought from the lightest touch down to almost a solid. Further density may be given if the pins at the heavy parts are "picked," as shown in fig. 164. For fine shading on faces of figures the pin is preferable to the stipple which shows too much of a mottle in this particular class of work.

Various punches are used for pin work. The shapes are outlined

Fig. 163.—Flat Effect from Pins

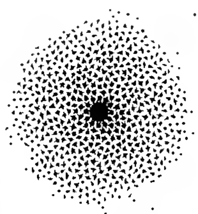


Fig. 164.—Pin Effect, "Picked."

with traverse points, and for covering surfaces the 19-pin ring is traversed, marking it lightly, and afterwards shading off with the single pin.

"Picking."—The term "picking" is aptly used to describe the taking away of small parts of copper at the corners of solid shapes, which would show a small speck of white in printing (see fig. 165). These are mostly caused by defective painting. A No. 3 two-point graver is most suitable for picking coarse grounds, and a No. 2 two-point for finer work.

An exception must be made with all cross overs (see fig. 166). For these it is advisable to employ a No. 4 single point for the purpose of preserving a clean edge, and prevent smearing in printing.

Mending is the placing of "plugs" or small pieces of copper wire into holes on the surface of the roller. These holes would retain

Fig. 165.—Showing Blotch Ground Unpicked.

colour when printing, and show defects on the cloth. The engraver has many sizes of copper wire to suit various sized holes, and fills them as follows:—

Having several sizes of mending chisels the most suitable one is selected. The engraver hammers the chisel, first to one side, then

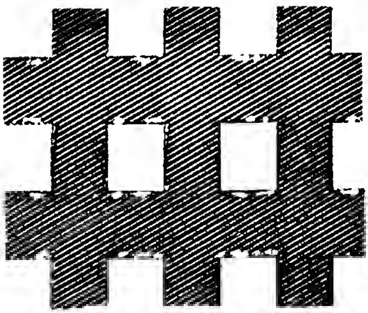


Fig. 166.—Cross-over Unpicked.

the other, making the hole wedge shaped (see fig. 167). A convenient size of wire is laid in the hole, and cut off with the graver; this small piece is then hammered down almost level with the surface. If there are only a few holes on the polished roller, several rubs with a finger

(polishing) stone reduces them to a level with the surface, or, if profuse, they are polished down when the roller is on the lathe.

Larger defects require different treatment, such as placing a short stretch of wire on the angle. When this is done, it is advisable, after opening up with the chisel, to make a hole at each end with a sharp pin, and thus give the mend greater security. A rub with the burnisher, after hammering down the wire, tends to solidify the copper. It is preferable to place in several short stretches of wire rather than a long piece, which is more liable to come out. Parts wrongly engraved can be repaired in the same manner, but great care

Fig 167.—A, Opening for wire; B, small holes; C, small holes plugged; D, large defects; E, large defects plugged

is required to be taken, especially with electro rollers, otherwise the copper plate will become loosened around the hole and ruin the roller.

Chiselling.—The object of using chisels on cross-over lines is to bring this part of the engraving to the surface. It has also the effect of hardening the copper, and withstands better the severe action of the doctor in printing.

The chisels are of various scales, coarse, medium, and fine, and also different widths of lines. The coarse scale is used for handker

Fig 168.—Face View of Chisels used for Cross-over Lines.

chief work, the medium and fine for garment work (see fig. 168). Previous to using the chisel, the lines must either be run out with the graver, or etched to take away some of the copper. The full width of the chisel is first struck in with the hammer, and the punch moved along two or three teeth at each stroke towards the left hand, thus traversing the punch along the line. When there are large stretches of lines it is advisable to have them done with the mill engraving machine. Lines around the circumference of the roller cannot be chiselled by hand, owing to the cylindrical shape of the roller, and must be done with the mill machine, except for small pieces when

the difficulty is overcome by the engraver "shaking" the line in the following manner :—A tooth graver is selected to suit the width of line, and while taking a slight cut the hand is rocked from side to side, which gives a "knurl" to hold the colour better, and prevents the line from "stripping" during the process of printing.

Wheeling.—These roulette or knurling tools (see fig. 147) are used by the hand engraver to impress a series of dots or fine angle lines where it would not be advantageous to do them in the mill machine, and only for short lengths on the circumference of the roller, for the same purpose as explained for "shaking." The wheel is pressed on the roller, and leaves a series of indentations corresponding to the wheel.

Dragging.—This term is most applicable for putting depth into grounds. It is done with a tool called the "drag" (see fig. 143). Both hands are employed when using it, the right hand on the handle, and the left to steady and direct the graver, which is fixed in a square hole.

The graver is pulled from left to right through the ground, care being exercised that an equal cut is taken out of each furrow without injuring the top of the ground. When the graver requires to be sharpened it is taken out of the holder, fixed in a graver handle, and whetted in the usual manner. The sharpening requires special attention, otherwise when replaced in the drag it will show a different cut, owing to the face of the graver being slightly flatter or sharper than previously used. Various single-point gravers are used according to the scale and depth of ground.

Examining Rollers.—When rollers are etched after engraving in the pentagraph machine, they are examined by the hand engraver, who touches up any weak or broken lines, mends acid holes, and rubs with the aid of the burnisher any scratches and pitch lines, previous to the roller being forwarded for polishing.

Should the engraving on the roller be an outline for a blotch, judgment should here be exercised, and any small holes allowed to pass where the blotch ground will appear.

Gravers used for touching up defects in pentagraph work require to be slightly rounded to imitate the bottom of the etched line. No. 3 or 4 single point suits best for the etched single line. The gravers used for cutting through defective grounds must also be rounded. Nos. 5, 6, or 7 single points are commonly used for this purpose. The graver can be easily rounded by lightly rubbing the edge on a piece of fine emery cloth, but they should be kept specially for this class of work.

Burnishing.—It will occasionally be found when examining rollers engraved by pentagraph that some odd sketches are slightly heavier, owing to the diamond point cutting keener than others. This may be rectified by applying the burnisher (see fig. 138), which tends to close the engraving, but care must be taken that the surface is not "sunk." If the engraving is too strong all over, this can be improved by a burnish in the mill machine, as explained under mill engraving.

Shade-line Effects.—Handkerchief designs after the style of fig. 169 require all the shade effects to be engraved by hand, owing to the

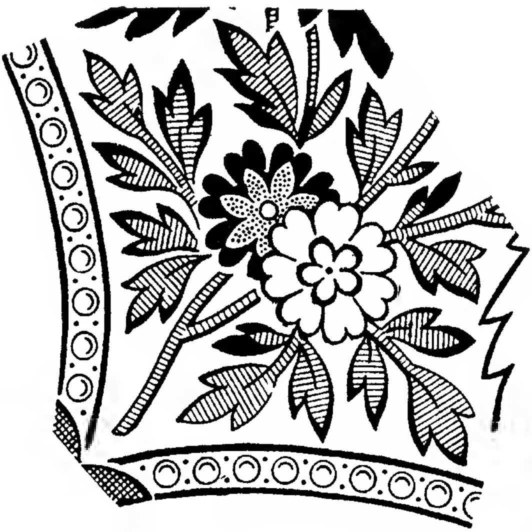


Fig. 169.—Section of Handkerchief showing Shade Lines engraved on various Angles

angles of the shade lines being "tossed" to suit the shape. A small scale (see fig. 28), usually impressioned on cloth, is kept by the engraver for deciding on the scale of lines to use. In the workshop are small zinc plates about 6 inches square with various numbers of lines to the inch; from these, wax impressions are taken, and transferred to the roller according to the angles required.

Fall-on Effects.—The engraver ought to study well the design when fall-on effects are required, and, if necessary, consult with the printer and merchant as to the variety of combinations in colour

that are desired, otherwise some unsatisfactory productions may be the result.

By one solid colour falling on another a different colour can be produced, thus—

Orange	produced by	pink	falling on	yellow.
Chocolate	,,	red	,,	green or blue.
Green	,,	blue	,,	yellow.

Half-tone effects can be secured by a shade line or stipple falling on a solid colour as follows :—

Salmon	produced by	pink stipple	falling on	buff solid.
Claret	,,	chocolate ,,	,,	,, ,,
Dark mauve	,,	red ,,	,,	blue ,,
Light ,,	,,	blue ,,	,,	pink ,,
Dark olive	,,	chocolate ,,	,,	light olive solid.

Mid effects can be produced with a shade line of the dark colour falling on the pale solid—*i.e.*, a red shade falling on solid pink, dark helio shade falling on light helio solid, or dark blue shade falling on light blue solid.

For outlining for half-tone effects, a No. 3 single-point graver is well suited, cutting a line about half strength, which ought to be regulated a little, either lighter or heavier, to suit a fine or coarse scale of shade line.

It is always advisable to rule the shade with a reverse ground to that of the solid on which it is falling.

Ruling Grounds.—*Fine Garments*, print on work. The solids on the "peg" rollers are usually ruled with 52 to 55 lines to the inch, and shade lines for mid effects with 70 to 80 lines, and the blotch with 48 to 52 lines for this class of work. If open sketches are on the blotch it is advisable to adopt the opener scale, and also keep it extra well on the surface.

Coarse Garments.—Print on or discharge, also fine handkerchiefs (such as two or three patterns on the roller), might be ruled with similar grounds, as follows :—The "peg" rollers with 45 to 50 lines to the inch, shade lines for mid effects with 65 to 70 lines, and the blotches with 38 to 45 lines, according to the construction of the design.

Coarse Handkerchiefs—for printing well through the cloth. The "pegs" can be ruled with 35 to 38 lines to the inch, and the

blotch with 32. Should mid effects be on the design, they may be ruled with 60 to 65 lines.

Large Kangas.—Two-colour and 72-inch circumference rollers. The black is ruled with 30 lines and the blotch with 25 lines to the inch.

These figures are given in a general way, but it must be understood that a certain amount of latitude requires to be allowed, owing to some printers desiring finer grounds than others, even for the same class of work.

CHAPTER XIII.

ENGRAVING FOR PAPER STAINERS.

The engravings for paper hangings are executed in a somewhat similar manner as to that done for calico. The work is done on solid copper cylinders, 36 inches wide, with similar bores, owing to the rollers

Fig 170—One-colour Example of Engraving for Paper Staining.

being printed in similar machines, only the designs are transferred to paper instead of cloth; but that all-important difference makes it possible for the engraver to give a finer class of work with equally

superior results compared with what requires to be done to give practical results on the cloth.

Hand Method.—The largest proportions of the designs are engraved by the hand method, owing to the repeats being of a large nature. Sketches on transparent paper are made for these, and transferred to the roller, as explained for hand engraving; one roller being used for each colour, except for fall-on effects, but these are not utilised to the same extent as for the calico.

Pentagraph Method.—The smaller repeat patterns can be engraved by the pentagraph machine, and finished off by the hand. A great amount of fine stipple work can be expended on the various effects that are wanted (see fig. 170), the finer touches showing to advantage on the comparatively smooth surface on which the engraving is printed. The "combing" and stipple work are accomplished in the same manner as for the calico, but the pins on the face of the punches are sharper, and require to be kept better up to this standard.

Grounds.—For the coarser and cheaper classes of paper, grounds are engraved to produce solids in the same manner as for the calico, but the scale of lines to the inch must be much closer, owing to the non-absorbing power of the paper compared with that of the cloth. Usually a scale of from 50 to 60 lines to the inch is sufficiently coarse, and the top of the ground must be kept better on the surface than for calico.

The field for this style of engraving is limited, and, consequently, carried on at fewer places, Darwen, Lancashire, being the principal centre.

CHAPTER XIV.

DIEMAKING FOR MILL ENGRAVING.

THIS method is adopted as a medium for engraving the finest class of designs. It is accomplished by either of two methods, which might be termed ancient and modern. The older system is still adopted principally for designs where outlines for the diemaker only are required, and consists of having a repeat of the design neatly drawn on transparent paper by the sketchmaker with transfer black or other colour, and then transferred by the diemaker on to the surface

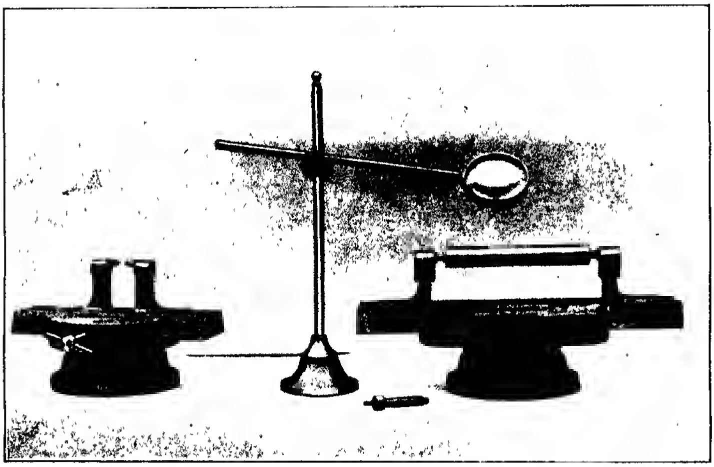


Fig 171.—Die Blocks and Diemaker's Eyeglass.

of the die, and engraved thereon. The newer system is aptly termed penta-die, from the method of procedure being the same as for pentagraph work, by way of preparing the zinc plate and transferring the repeat to the die (covered with varnish), and thereafter etching with acid. The older system requires greater skill and judgment on the part of the diemaker, owing to the difficulty of engraving on the

steel direct while retaining the neatness and precision of shape, so necessary in this class of work.

Die Block (see fig. 171).—This apparatus is used by the diemaker for holding the die, and is made with a circular iron sole-plate, in which is a hole about 2 inches in diameter. The body of the block is made of hard wood, on the bottom of which is a short iron pillar which fits into the sole-plate, and allows the diemaker the advantage of moving the body round as required. Running across and below the level of the sole-plate is a steel spindle, screw-cut right and left from the centre. Attached to this spindle are two arms, one on the right screw and one on the left, with projecting points at top. The die is held secure by adjusting these projecting points of the arms into "centres" on the pivots of the die or mill, and tightening the screw.

Setting out the Die.—The diemaker on receiving the sketch, first sets out the lines on the die corresponding to the sketch. The die is placed in the block, and a centre line scratched with the ruling fork, also repeat lines for the side distance. The V straight edge is laid across the surface of the die and a line drawn across, also sectional lines in the circumference, if required. If lines on the slash are required to be ruled, a flat piece of brass having a deep line across the centre can be fixed on to the sole of the die block, and the required slash adjusted by canting this piece of brass on the slot at the screw pin. The point of the fork is then rested on the die and drawn across the groove. The die is now coated with resin varnish, and when about dry (just slightly tacky) the sketch is laid down and a transfer taken.

The diemaker now proceeds to cut the leading colour with a No. 4 single-point graver, stronger than the other colours, which are only hair lined. It should be noted that a separate die is required for each colour on the design. Impressions are then taken from this die and transferred to the others, the operator engraving alone the parts required for the respective colours.

Grounds.—When all the fine parts and outline of solids are engraved the required strength, the ground is next attended to, and a scale of line selected in accordance with the surrounding work, which may be from 75 lines to the inch for large solids up to 120 lines for small solids (see fig. 172).

Grounds may then be cut with a two-point graver in traverse manner, or an impression transferred and cut with a single point. Skill and care are required to engrave a satisfactory ground on the die, which ought to be just slightly under the surface and level. This will be shown to advantage if the die is dipped in acid to blacken

it all over, then polished to clear the surface, thus showing any defects in the ground which remains dark.

The learner requires to avoid the tendency to cut the ground deep at the edge of the shapes.

Where very large solids are on designs it is advisable to only outline the shape and rule the ground. If the ground be placed on the die for moderate sized solids it is a great convenience to the machine engraver if a cross cut is taken out of the solid (see fig. 173), which allows an escapement of "burr" during the process of machining.

For cutting very fine grounds a No. 7 or 8 single-point graver is best suited. For medium a No. 6, and "backed" with a No. 5. For a coarser ground a No. 4. The coarser the ground it must be corre-

Fig. 172.—Ground in Solid Shapes.

Fig. 173.—Showing Cross Cuts in Solids

spondingly deeper, and requires to be cut through several times to obtain the necessary depth, and after polishing the die, again touched up, taking away any thick parts on the ground that would have a tendency to show grey when machined.

Chiselling.—Stems of a flowing nature (see fig. 174) require to be chiselled, thus putting a "knurl" in the bottom of the line, which allows the engraving to furnish better in printing. For this the chisels used may either be line or pin.

Pin Work.—Where pin work is required in small leaves, as shown in fig. 175, they are marked on with a traverse pin selected from a scale, and shaded off to the required strength.

Ombrè Effects.—*Ombrè* effects are better marked on very lightly *en masse* by the clammer. Usually a scale is selected from the well-

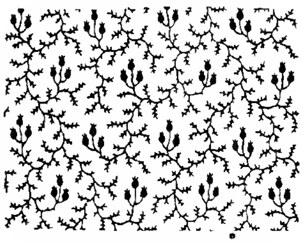


Fig 174 -Stems of a Flowing Nature that require to be chiselled

Fig 175 —Pin Leaves marked on with Traverse Pin Punches.

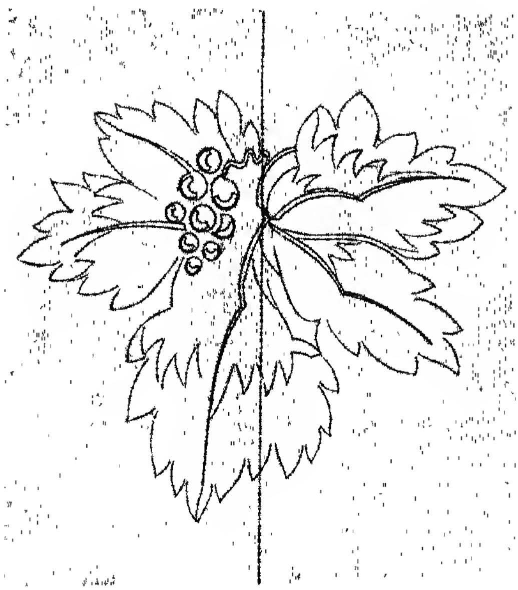


Fig 176—Pins run over *en masse* by Clammer

known seven pin (see fig. 176), which is then worked up by the die-maker, as shown in fig. 177.

This class of work requires the greatest skill in diemaking so as to give a perfectly graduated shade from a solid out to the finest touch. It also occupies a great amount of time, owing to the raising of "burr" in the tapping of the pins, the polishing away of which necessitates the working up of the darker parts several times, also "picking up" the pins, to get the necessary depth of shade and "bloom" imparted into this difficult and "tricky" class of work.

Mechanical Drill.—There has recently been introduced an appliance which saves a great amount of time in working up *ombrè* effects com-

Fig 177.—Pins worked up by Diemaker with Mechanical Drill

pared with the older methods of finger and bow drill. The apparatus is simply an adaptation of the dental drill (see fig. 178). Attached to the top of the drill piece is a flexible tube carried through an outer covering which serves as a protection. The end of this tube is connected to a small steel rod with groove which is inserted into a small pulley. From this small pulley a cord is connected to a larger pulley (about 14 inches diameter) on shaft overhead, thus obtaining the high speed required for the drill. With a little practice the diemaker becomes expert in using this drill to great advantage

thus doing away, to a great extent, with the slower method of the finger and bow drill. Various sizes of drill bits can be inserted into the stock.

Another method for *ombrè* stripe effects for which either the pad (angle-pin line) (see fig. 179) or seven-pin arrangement can be

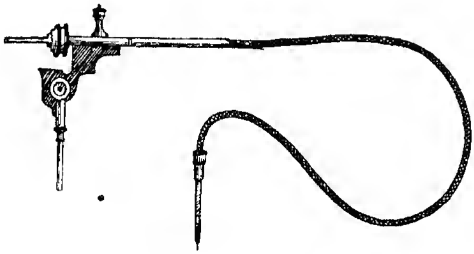


Fig. 178.—Mechanical Drill.

used (see fig. 180). The mill of these is run full strength on to a die, and the outline of the design then engraved through the pins, as shown in fig. 181. A mill is then raised and the parts where the whites of the design appear are pared away with flat belly gravers on a level with the surrounding surface. This adaptation certainly saves a great

Fig. 179.—Pad, Angle Pin for *Ombrè* effect.

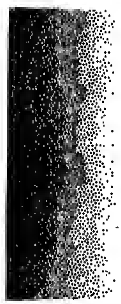


Fig. 180.—Mixed or Seven-pin *Ombrè* Stripe.

amount of diemaking, but great care requires to be exercised in the paring away, not only to avoid slips which would ruin the mill, but also to see that it is thoroughly level, otherwise it will cause a great amount of trouble in machining by having unnecessary "sinks" on the roller, which again entail further labour to erase.

Various Effects.—Diemaking is the medium *par excellence* for working up effects which it is impossible to obtain from pentagraph or hand method.

Fig. 181.—Outline of Flower engraved and Pins pared away.

Fig. 182.—Superpose Effects from Pins.

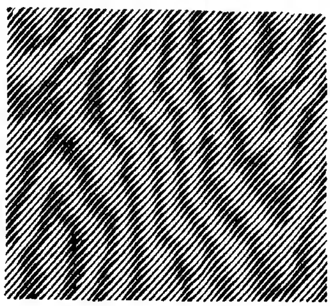


Fig. 183.—Watered Effect.

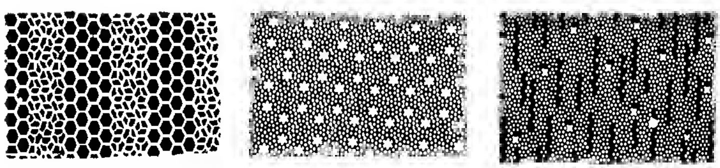


Fig. 184.—Patterns worked out from Honeycomb Grounds.

Various tones and superpose effects can be produced (see fig. 182), also "watered" effects, as shown in fig. 183; honeycombs, as shown in fig. 184; and woven effects, as in fig. 185.

The good taste and skill of the diemaker can be shown to advantage in many respects regarding detail, by giving leaves the necessary curve to maintain the law of growth, also to secure the desired plumpness. Again, with the common square much can be done by a slight

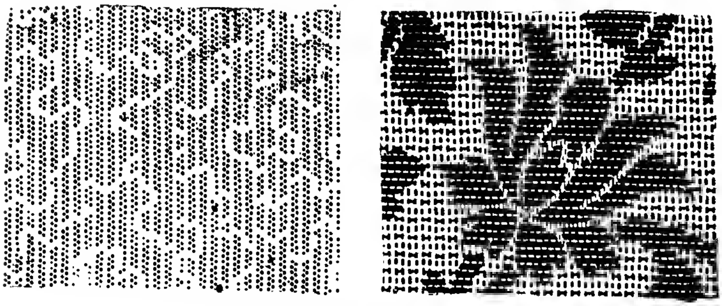


Fig. 185.—Woven Effects.

curve in the centre, which secures a sharpness, otherwise lost if the square is formed with straight lines.

Traverse Work.—The arranging and working out of geometrical

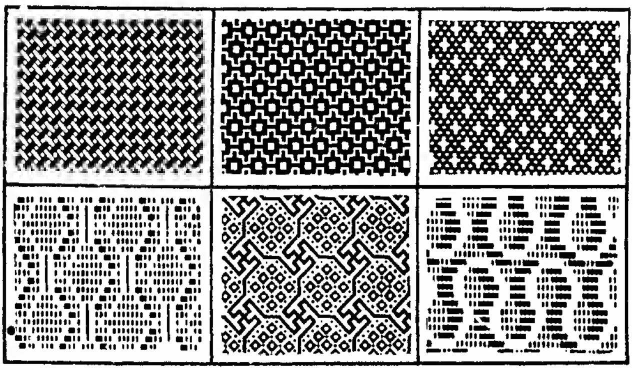


Fig. 186.—Traverse Designs worked out from Pin Grounds.

designs might be termed an art, and in the hands of a skilful diemaker many beautiful effects can be produced (see fig. 186). The ground work of traverse designs is obtained from the square, step, diamond,

and mixed pins (see fig. 187). The various scales are usually marked on what is termed a trial die. The diemaker may crudely shape out his ideas on paper first, previous to using the trial die for further detail.

The clammer next gets instructions to prepare a die, say with No. 7 square pin, eight pins in sketch, and three sketches on the die. On receiving the die the shape is cut from pin to pin, thus forming

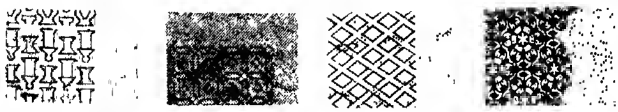
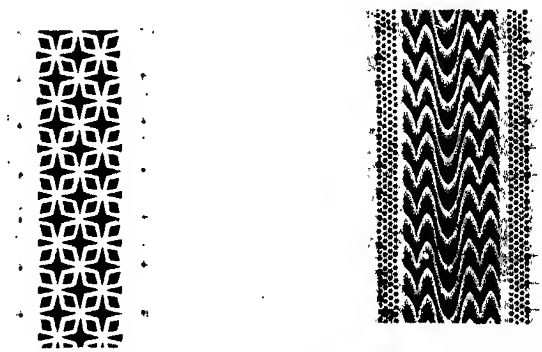


Fig. 187.—Showing how Designs are worked out from various Pin Grounds.

the design as planned on the trial die. Each unit on the die must be similar for the purpose of traversing—*i.e.*, linking perfectly into each other.

"Snags," for the purpose of raising the mill to traverse perfectly, are carefully placed on each side of the work in accordance with the repeat, as shown in figs. 188 and 189.



Figs. 188 and 189.—Showing how Snags are placed on the Die for raising the Mill.

Diemaker's Outfit.—An immense selection of tools and punches can be enumerated to make up a valuable outfit for a diemaker. This equipment can only be obtained gradually, but should be aimed at by every skilful tradesman. Apprentices should be careful about rushing into the making of many of the tools before he acquires the skill and knack of producing them perfectly, otherwise they are of

little value. In the case of some of the tools, such as drills and stocks, it is advisable to pay a skilful engineer for making them.

The following might be enumerated as a well-equipped outfit :—

1. A good strong tool box with fittings inside in the shape of "trays."

2. Set of three Vs (see fig. 190). These might be termed diemaker's straight edges, and are used for ruling cross lines on dies at right angles to the circumference. They are usually 3, 6, and 9 inches long, and made of steel forming a right angle with a bevel at outside towards the face.

3. One ruling fork. This tool is constructed in the same manner as used for rollers, only on a much smaller scale, usually about 3 inches in height. It is used for scratching lines around the die.

4. One bow drill (see fig. 191). This is manipulated with a small bow and used to work up pin effects when the finger drill would be too weak. It is now being supplanted by the mechanical drill.

5. One stock or pin whetter (see fig. 192), which is used for whetting up pin punches in the same manner as explained for hand engraving.

6. An eyeglass in stand, as shown in fig. 171; it is placed on the sole of the die block when working. Also a glass for fixing on the left eye when a freer movement is desired.

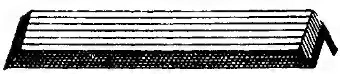


Fig 190 —Diemaker's V or Straight Edge

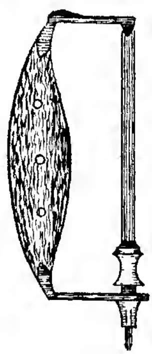


Fig 191 —Diemaker's Bow Drill.

7. Selection of gravers from Nos. 1 up to 8 single points and Nos. 3 up to 8 two points with various handles.

8. Two hammers. A light one used for ordinary work and a heavy one for raising punches.

9. One drill step (see fig. 193). This tool is used for whetting drills for opening out pins. It is shaped as the name indicates and made of brass about 2 inches long and 1 inch in height.

10. One finger drill (see fig. 194). This is made from a piece of steel about 5 inches long and tapered towards the point. It is used for putting depth into pins without raising "burr," by rolling it between the thumb and first finger. The cutting point must be

and mixed pins (see fig. 187). The various scales are usually marked on what is termed a trial die. The diemaker may crudely shape out his ideas on paper first, previous to using the trial die for further detail.

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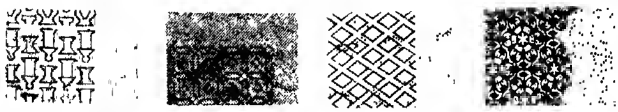
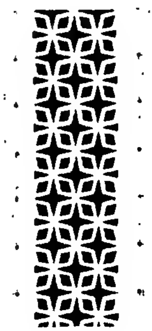


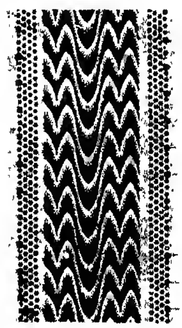
Square Pin Step Pin Diamond Pin Mixed Pin

Fig. 187.—Showing how Designs are worked out from various Pin Grounds.

the design as planned on the trial die. Each unit on the die must be similar for the purpose of traversing—*i.e.*, linking perfectly into each other.

"Snags," for the purpose of raising the mill to traverse perfectly, are carefully placed on each side of the work in accordance with the repeat, as shown in figs. 188 and 189.





Figs. 188 and 189.—Showing how Snags are placed on the Die for raising the Mill.

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13. Several ground dies.
14. ,, stipple dies.
15. Die for single rings.
16. ,, ,, with pin in the centre.
17. ,, pin rings.
18. ,, spots.
19. ,, skeleton squares.
20. ,, solid squares
21. ,, traverse pins
22. ,, single pins.
23. ,, small rosettes.
24. ,, seed shapes.
25. ,, pear shapes.
26. ,, pine shapes
27. ,, oval shapes.

Also set of punches raised from dies Nos. 12 up to 27.

A packet of various small files are also useful for a diemaker, and two pairs of steel spring dividers.

CHAPTER XV.

PUNCHMAKING FOR CALICO ENGRAVING.

THIS department is usually linked up with diemaking, but apart from it there is an art in making punches, which few men acquire to the same degree of perfection as those trained in a stampmaker's shop. Many sets of punches, such as figures and letters, can, therefore, be purchased from a practical stampmaker cheaper than they can be made by the calico diemaker.

Tools Required. — For punchmaking the following tools are required :—

One 14-inch coarse file for "roughing up."
A set of small assorted files.
A hand vice and a pair of pliers.
An eyeglass and stand.
Two hammers (one heavy and one light).
A bow drill.
A blowpipe.
A pair of steel spring dividers.
Several small chisels.
A few gravers (single point).
Water jar for hardening and tempering.
A punchmaker's block.

Punchmaker's Block—Description and dimensions (see fig. 196).—The block is made of cast iron with movable steel jaws. It has a pivot on the bottom, which is inserted into a block of hard wood. The iron block is circular in shape and $7\frac{1}{2}$ inches in diameter by $2\frac{1}{2}$ inches deep. The pivot is $2\frac{1}{2}$ inches long by $1\frac{1}{2}$ inches in diameter. A flange of about 2 by $\frac{3}{8}$ inches at the top of the pivot is necessary to allow the block to revolve on the wood sole, which should be about 6 inches square and $2\frac{1}{2}$ inches deep.

The hole in the iron block is about $3\frac{3}{4}$ inches long and $1\frac{3}{4}$ inches wide by $1\frac{3}{4}$ inches deep, and nearer the one end than the other, as shown in the illustration.

Between the steel jaws, which fit into the hole, is a space to allow

of the punch being inserted. One of the jaws is $\frac{5}{8}$ inch in thickness and the other $1\frac{3}{8}$ inches. The screw at the one side should be strong, say $\frac{3}{4}$ inch in diameter, and have a good deep thread.

Steel for Punches.—This should be of the very finest quality, and can be simply tested by polishing a small part and placing a drop of nitric acid on it. This should produce a black spot. The harder the steel the blacker should be the spot. Iron, on the contrary, remains bright if touched with nitric acid.

Good steel in its soft state has a curved fracture and a uniform grey lustre. In its hard state it has a dull silvery uniform white appearance. Cracks, threads, or sparkling particles denote bad quality. Good steel will not bear a white heat without falling to pieces, and will crumble under the hammer at a bright red, while at a middling heat it may be drawn out to a fine point. Punch steel usually costs about 6d. per lb. and is purchased in long bars.

Steel required to make assorted sets of punches can be had of the following sizes:—

$\frac{1}{8}$, $\frac{3}{16}$, $\frac{1}{4}$, $\frac{5}{16}$, $\frac{3}{8}$, $\frac{7}{16}$, $\frac{1}{2}$ inch square.

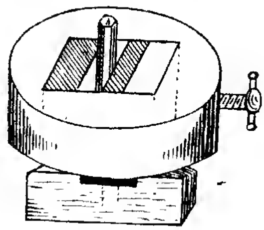


Fig. 196.—Punchmaker's Block.

Punches require to be $2\frac{1}{2}$ inches long, but in cutting the steel into lengths $\frac{1}{8}$ inch extra is allowed for filing and dressing up the ends.

Cutting the Steel.—Having a pair of dividers set to $2\frac{5}{8}$ inches, this distance is marked off on the bar, then with a three-cornered file a deep incision is made on the four sides. The thicker sizes are gripped in a large vice and with a quick stroke of the hammer are neatly snapped off at the file marks. Care must be taken to have the incisions deep enough so that one blow of the hammer shall break off each piece. If steel is struck more than once it has a tendency to bend slightly, and when once bent no end of trouble arises, both in the making of the punch and also when it is in use.

Softening the Steel.—Having broken the bar into punch lengths, the pieces are made soft by placing them in a fire until they turn bright red, then smartly plunge them into dry lime or Portland cement; even fine ashes make a good substitute to exclude the air to some extent. Allow them to remain there until quite cold.

After being withdrawn the ends are squared up and the corners taken off the square with the coarse file. A punch is easier held when the corners are not too sharp or "peaned" as it is termed. The heads are also filed up in an octagonal manner; the centre of the

head should be exactly in the centre of the steel. The face should be filed carefully up to about the size of what the finished punch will represent. By this means it is more easily raised, as it requires less hammering.

Spots.—These are punches with a ground or lines inside the circle for the purpose of obtaining a solid print. The older method for raising spots was from a fine ground die (see fig. 197, A). Forty pieces of steel, or fewer, according to the number arranged for the set, are filed up, the first with a very fine point and gradually getting larger on the face as the numbers advance. All the pieces are then hammered on the ground die, which is fixed in the block until the lines are fully brought out into relief, care being taken that the punch is held square when striking it into the ground. Numbers from one upwards are then marked on the side of the pieces.

A die with a tapered hole (see fig. 197, B) is then placed

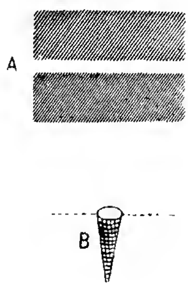


Fig 197 —A Impression from Fine Ground Die

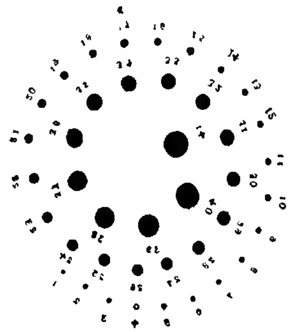


Fig 198 —Impression from Spot Die

in the block and the smallest size, which is equal to a fine pin, is gently tapped with the hammer into the hole, then No. 2, and so on until the largest size is towards the top of the hole. This makes them perfectly round, but much depends on the skilful eye of the punch-maker to see that a perfect gradation in the sizes have been secured. This method is not the best, and can only be recommended when a good spot die cannot be secured.

In all cases the steel to begin with should only be filed at the point with a short taper or "candle," as it is termed, until the punch is raised, otherwise it is liable to bend. Then in the finishing all the set can be filed to a proper taper.

The other and more safe method is to raise the spots from a die, as shown in fig 198, and thus dispense with the hole for adjusting

the size. The steel is treated in the same manner as already explained. It is better to first number the punches from 1 upwards and strike them into the corresponding numbers on the die. Care must be taken that the spot die is fixed square in the block, and the spot struck exactly in the centre of the steel, also that the punch is held square when using the hammer.

Single-edged Rings (see fig. 199) for the die.—These are sometimes termed skeleton rings—*i.e.*, a fine line forming a circle. They are graduated in the same manner as the spots. The steel requires to be treated in the same way, as already described, and also numbered as a guide for the hand engraver. The steel is first struck on to the die, and when the outline is thoroughly "bottomed," or raised in relief, a sharp pin is used to make a centre on the ring for the purpose of using the bow drill to clear out the steel in the centre. Great care

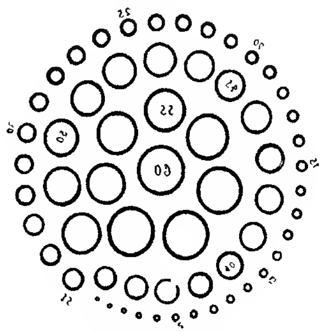


Fig 199.—Impression from Single-ring Die

must be taken to leave the outline untouched by the drill. Several sizes of drills require to be used for each six punches or so, sharp for the smallest rings and flatter as the sizes ascend.

A set consists of about 60 graduated sizes.

Double- or Thick-edged Rings.—These are prepared in the same manner as explained for single-edged rings, and are most useful for hand engravers (see fig. 200).

There are usually four sets with different degrees of thickness on the ring, each set being of a uniform thickness. The O set is the finest and has a very thin bondage (a shade thicker than the single rings), No. 1 set is a little thicker, No. 2 set thicker still, and No. 3 set is the thickest of all. Each of the sets have about 45 sizes with a "chased" ground on the face of the ring. They are marked with

the distinguishing figure as well as the figure for gradation in size of ring.

Single Pins.—These are placed on a die and have 12 pins of a graduated size, from the sharpest point down to a good thimble shape, as shown in fig. 201. When raising punches from these, special care should be taken to see that the point is exactly in the centre of the steel. As with other punches, they are raised with a short taper and a longer candle filed up afterwards. Also note that when hardened

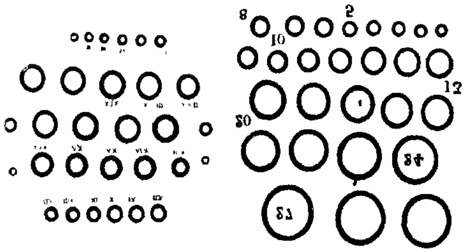


Fig 200 Impressions from Die, thick-edged rings

they are not "let back," and are the only punches treated in this exceptional manner.

Traverse Pins.—These are punches with two pin points raised in relief. They are made from $\frac{1}{8}$ inch square steel for the fine set and $\frac{1}{4}$ inch square fo. the coarse set. Each should consist of about 25 punches.

The points, which are very sharp, should be marked on steel having a very short candle. A file and a No. 1 single-point graver is then used to clear in between the points of each punch.

Fig 201 —Single Pins, thimble shaped.
A, Shows surface area
B, Shows depth of pins

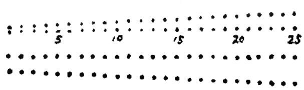


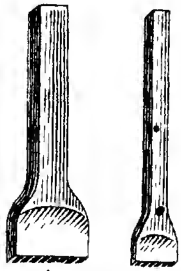
Fig. 202 — Traverse Pins
A, Fine set
B, Coarse set

The scale of pins are graduated off as shown in fig. 202.

Ground Chisels.—These punches are of various widths, depths, and breadths to correspond with the nature of the engraving upon which they are to be used. Some prefer long-faced chisels, others short faced, as shown in fig. 203. As chisels are much used, it is preferable

to make them from $\frac{5}{16}$ inch square steel, and, if necessary, get the ends hammered out for the long face.

They are used for cross-over line work and also at the edges of solids for the purpose of hardening the copper to withstand better the action of the doctor while printing. When raising deep chisels, such as are used for handkerchief rollers, they are first marked on from a ground die (see fig. 204) which is fixed in the punch block,



A B

Fig 203.—A, Long-faced chisel. B, Short-faced chisel

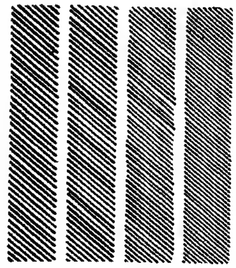


Fig 204.—Impression from Ground Die for raising Chisels

then a single-point graver is used to deepen the space between the teeth.

Stipple Punches.—The raising of these punches in a thoroughly satisfactory manner is most difficult to accomplish, and requires greater skill than any of the others. At the same time a perfect die (or as near perfection as possible) ought to be secured for the purpose. In common use there are four scales of what is termed the 19-pin (see fig. 205).

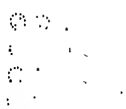


Fig. 205.—Impression from Die for raising Stipple Punches, 19 pins on each ring

Fig 206.—Impression from Die showing 10 and 6 Pins for Stipple Punches.

The face of the steel should be filed up in the same manner as directed for the making of spots, the centre of the steel being in the centre pin of the stipple on the die. The punch is then struck gently with the hammer until the pins are formed on the face. The outer row of pins is assisted in the raising by gently touching the points of the centre pins with a very fine file. When the pins are almost

perfect, special care must be exercised in using the hammer, On a perfect stipple die the punch should be continually turned. although some punchmakers prefer to retain the same position until completely raised. Stipple punches must be perfectly flat to be of good service.

For the purpose of going into corners and intricate points various shapes of punches are raised out of the 19-pin stipple. There is the 7-pin secured by omitting the outside circle of 12 pins; then the 10-pin and the 6-pin shapes, both of which form a seed shape. The 10-pin shape, when made from the 19, is usually not such a well-shaped punch as one made from a die specially with the 10-pin. It is well, therefore, that these odd shapes be also made on the die, as shown in fig. 206.

Pin Rings.—These punches in appearance closely resemble the

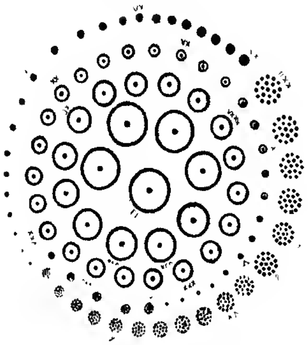


Fig. 207.—Impression from Die showing Pin Rings, also Single Rings with Pin Centre.

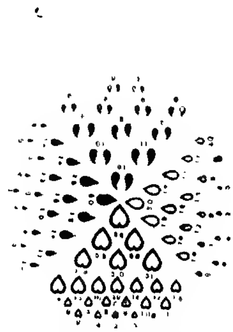


Fig. 208.—Impression from Die showing Pear Heads and Heart Shapes.

stipple. A set on a die may consist of 50 different sizes, graded from size 0, the smallest, up to about $\frac{1}{4}$ inch in diameter, as shown in fig. 207. They are used for covering surfaces, as explained under hand engraving.

They are raised in the same manner as stipple punches, but after they are perfect on the face, a graver for the finest, and a fine knife file for the larger rings, is used to clean in between the outside row of pins.

Various Shapes.—Punches are often made for shapes that do not come under any special or stock set, such as pear heads or heart shapes, as shown in fig. 208. For larger shapes (see fig. 209) a sketch from the design is drawn on transparent paper and transferred to the face of a piece of steel and the outline engraved. The inside is then cleaned

out with a drill, a chisel, or a flat-belly graver, as the nature of the punch requires.

Counter Sinks.—These punches are seldom used in the making of ordinary punches, but for figures and letters they come in very handy for repairing these. A counter sink is a punch that is made to fit into the hollow parts of another punch (see fig. 210, D).

Reading of Punches.—A punch for engraving purposes reads correctly from left to right (see fig. 210, E), and when struck on the

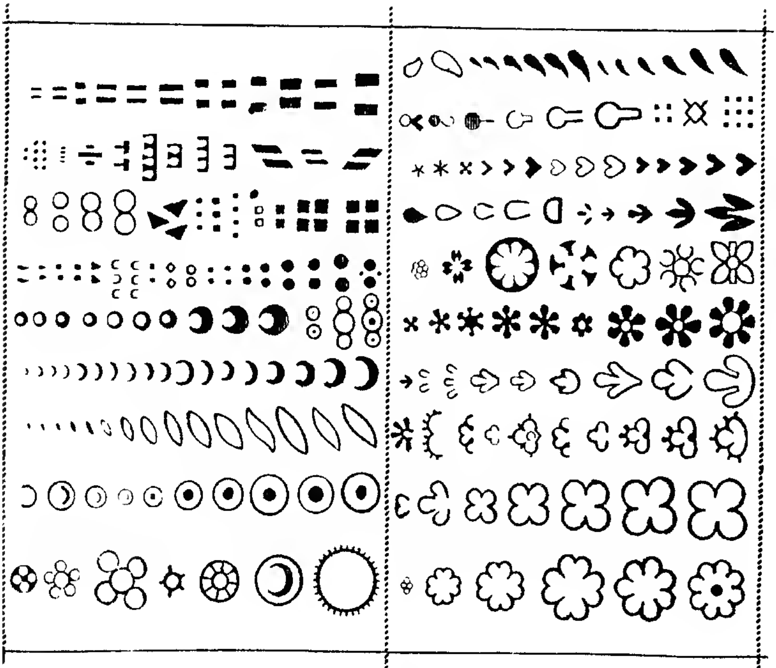


Fig. 209.—Impression from various Shapes suitable for making Hand Punches

roller will appear reversed. When the roller is printed it again reads correctly. A punch for numbering rollers or tools is reversed on the face (see fig. 210, A), but when struck on will read correctly.

Punches for Punching Machine.—A sketch is drawn in the same manner as explained for "various shapes" and transferred on to a piece of steel, the face of which is convex in accordance with the circumference of the roller on which the shape is to be engraved. It is also cut out in a similar manner, as detailed for various shapes.

The piece of steel is then hardened and raised in relief (on a punch block specially used for this purpose) on to a concave-faced piece of steel, the head of which is shaped to fit the holder of the punching machine.

This method can only be employed with suitable one-colour patterns and for the sake of economy, owing to the punching machine being self-acting when set and started, it is found in most cases that the style of patterns suitable for the punching machine can be as economically wrought out in the ordinary mill engraving machine, the roller of which can be easily repaired, which is not the case with the pattern engraved on the punching machine.

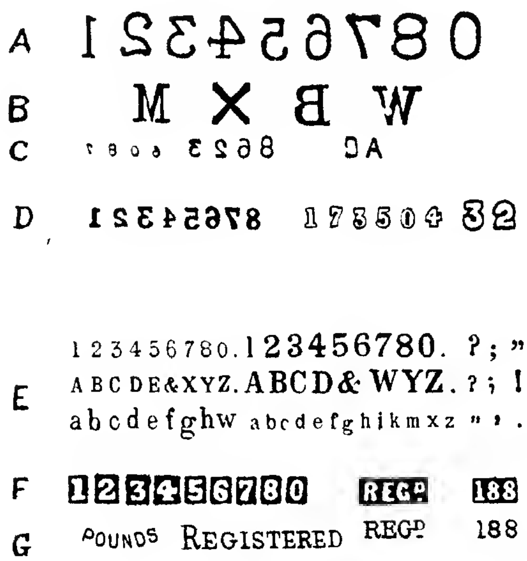


Fig 210

A, Figures used for stamping rollers
B, Letters used for stamping rollers
C, Figures used for numbering punches, dies, and other tools
D, Counter sinks used in making figure punches.
E, Various figures and letters used in engraving patterns
F, Style of figures and letters used when surrounded with colour
G, Punches made with complete words for white ground patterns

Hardening Punches.—Dissolve some common salt in cold water, and place the jar containing this in close proximity to a gas jet. The punch is gripped in a hand vice and the face end held in a gas flame until it turns to a bright red, then quickly dipped or dropped into

salt water. The blowpipe is used for larger punches, the gas flame not being powerful enough.

Extra large punches are better to be hardened as explained for dies and mills.

When a punch is made red hot all over, care should be taken that it is not all made hard in the dipping, because, if a punch is very hard all over, it is liable to chip or break, and is also dangerous to the operator when being used.

Tempering Punches.—Before a punch is ready for use it requires to be tempered or " let back " (after it is hardened) in the following manner :—The punch is polished at the taper towards the face end on a piece of fine emery or carborundum cloth laid on a bench, care being taken while rubbing that the face is not touched. A little oil

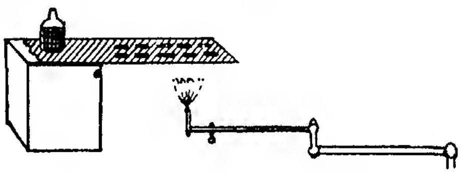


Fig. 211.—Method of tempering Punches.

is then spread on the punch which is held with a pair of pliers in a small gas jet, until it becomes a light straw colour, then dropped into a jar containing salt water.

A quicker method can be adopted, as follows, when a complete set of punches require to be tempered :—

Procure a piece of sheet iron about 12 inches long and 8 inches broad, and rest it on the top of a wood block, as shown in fig. 211. Arrange the punches in rows and keep the gas flame moving beneath the sheet iron. As the punches turn to a light straw colour, they are lifted with pliers and dropped into the jar of salt water. As in tempering other punches, it is desirable that a little oil be poured over them. It is reckoned that oil tends to toughen the steel in the process of tempering.

CHAPTER XVI.

DIE AND MILL TURNING; ALSO CLAMMING.

These operations might be termed the engineering department of the engraving shop, and require great accuracy and skill to be exercised in preparing the tools, if the best results are to be obtained with the mill engraving.

There are two kinds of dies, "round" and "flat." The round is generally used, and for many reasons. They are easily prepared, better shaped mills are obtained from them, are quicker clammed, and are alone suited for all classes of repeat designs. The limitations of the flat dies will be dealt with later.

Preparing the Round Die.—When the sketchmaker has finished his part of a design to be engraved by the mill, an instruction sheet is forwarded to the clammer to prepare, say, one die seven round, which means seven sketches or repeats on the circumference of the roller. If the design contains more than one colour, a die is prepared for each colour, all being the same in circumference. After measuring the width of engraving to be placed on the die, and allowing $\frac{1}{4}$ inch plain on each side, also space of $\frac{1}{2}$ inch for snags and an allowance of 1 inch for the pivot on one end, a piece of round mill iron is cut the required length, into which a hole is drilled at each end for centres to run in turning lathe (see fig. 212). The body and pivot are then rough turned to nearly the required size.

Welding Pivots.—With large dies and mills it is rather laborious work "roughing" part of the body down to the size required for the pivots. It is, therefore, good economy to saw off the required length and get the pivots beaten out of the body by the aid of the steam hammer.

At this stage much depends in having not only a correct sized die but also well-shaped as regards the concave form.

Sizing the Die.—The circumference of the roller (when turned and polished) on which the engraving is to be done is then marked on a piece of copper tape and divided into the required number of repeats or sketches on the circumference of the roller. To this is added what is termed clamming allowance (as shown on scale in

fig. 213), equal to about $\frac{2}{100}$ of an inch for every sketch or repeat on the circumference of the roller. Seven repeats equal $\frac{14}{100}$ are then added to the size of the roller taken on the copper tape. According to the

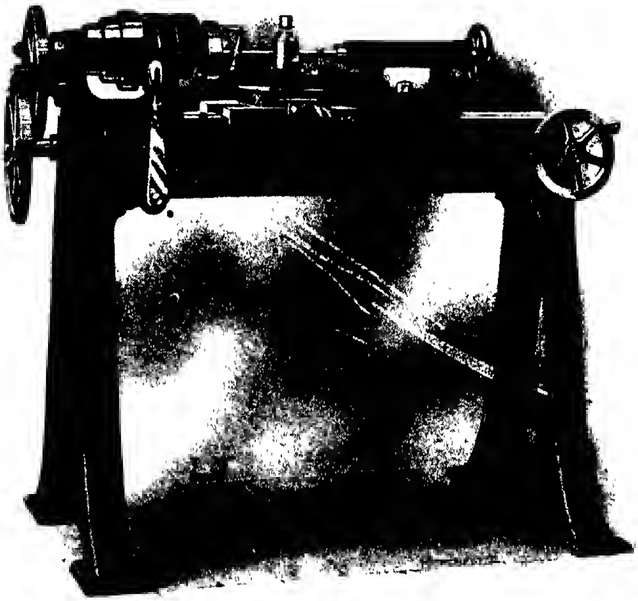


Fig. 212.—Mill and Die-turning Lathe.

style of work judgment is exercised at this stage, and more allowance given for open than for close work.

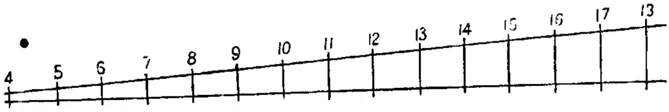


Fig. 213.—Scale for Clamming Allowances.

Shaping the Die.—All the dies are made concave—*i.e.*, slightly smaller in circumference at the centre of the body and gradually

tapered up on each side (as shown in fig. 214 in a slightly exaggerated form).

Pivot and Square on Die.—A pivot is required only on one end of the die for the convenience of handling and giving a grip with tongs when lifting out of the case-hardening pot so as not to injure the body. A square is sometimes filed out of the pivot for traverse dies.

Polishing the Die.—It is necessary to have as good and clean a surface on a die as on a roller. The tool marks are taken away with a fine file and then a Turkey hone used with the aid of some oil to put a high polish on the surface. The die is then coated with varnish and pentagraphed, or placed in the diemaker's hands if it is to be engraved from a sketch.

Mill Iron.—The best quality of steel is scarcely necessary for dies and mills, as the surface only requires to be hardened; therefore rolled or mill iron is quite good, and much cheaper than steel. At the same time it must be clear of fractures or reeds in the metal, otherwise bad results will follow during the process of case-hardening by these reeds opening up on the die, and all the labour expended thereon will require to be done over again.

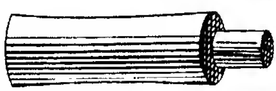


Fig. 214.—Die showing Concave Shape

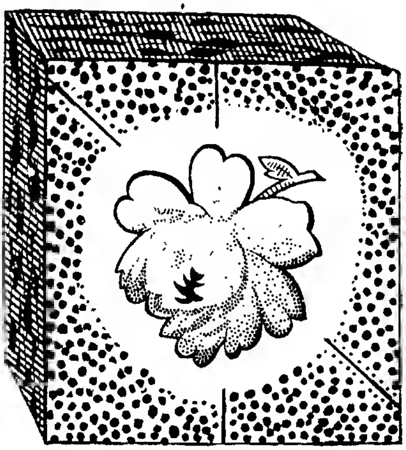


Fig. 215.—Flat Die

Flat Dies.—This form of die (see fig. 215) is confined to a limited class of work called "bumps"—*i.e.*, sprigs outstanding and having no continuous engraving from one repeat to another, or handkerchiefs with corners and borders chased, and well that it is so, owing to the difficulties and risks in working them. They are only advantageous and justified when a large sprig of intricate detail with many positions occurs in the repeat, thereby saving a great amount of diemaking.

If a design has a very elaborate sprig with a variety of four positions of the same object in the repeat (as shown in fig. 216), a flat die could

be prepared and only one object engraved. Four separate clammings would have to be done, say, two positions raised on each mill; but, notwithstanding this expense, a great economy has been effected in diemaking. To avoid the flat die in cases such as this, it is better to try and arrange a plan with two positions, half turn (as shown in fig. 217), which still gives four positions and allows a round die to be prepared, with the two positions engraved; it also admits of one mill being raised, which can be turned round in the mill frame by the machine engraver and give the four positions on the roller, as shown in the last figure. For preparing a flat die it is advisable to use good steel, as composition is more liable to twist during the process of hardening. The square selected should be much larger than the

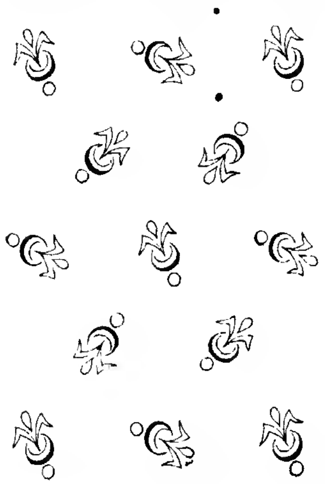


Fig 216.—Showing Four Positions. Step half.

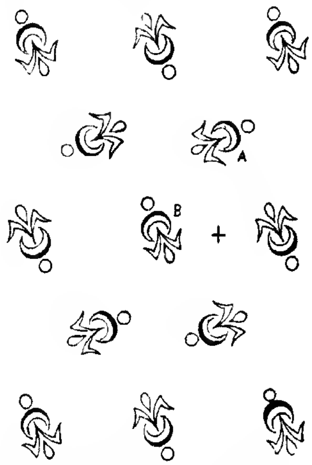


Fig 217.—Showing Two Positions, A and B half turn - four positions Step half.

engraving required, and also be of thicker material as the surface increases, from ½ inch thick for small sprigs up to 1 inch for large surfaces. Both sides can be used for engraving. It is well to ascertain that the material is soft. If it is not, it is advisable to place it into a box in the furnace; when brought to a cherry red, it is withdrawn and allowed to cool. The surface may require to be dressed in the planing machine, then ground and polished by hand to a graduated concave shape about $\frac{1}{32}$ inch deep at the centre. This can be tested by placing a straight edge across the die, turning it round and examining it from the level of the eye. This concave shape is

absolutely necessary in order to ensure a well-shaped convex mill being raised therefrom. It is more difficult to secure a perfectly concave shape on the flat than on the round die, and this is the principal reason why they are so much avoided.

The flat die may either be engraved in the pentagraph, a specially constructed appliance being used, or a photo or sketch be transferred to the surface. After engraving the sprig, pitches are marked for the various positions and snags placed around the engraving, as shown in fig. 215.

Snags.—When the diemaker's part is complete on round dies, holes are punched in an irregular manner, as illustrated in fig. 218, and termed "snags." These are required when raising the mill to prevent it from slipping when pressure is being applied during the process of clamming.

Case-hardening.—After "snagging," the dies are placed in iron pots to be case-hardened. With every round die there should be, at least, 1 inch space between the surface of the die and the inside of the pot. A layer of fine bone pieces are placed in the bottom.

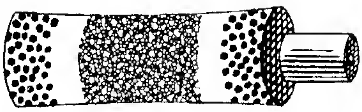


Fig. 218.—Showing "Snags" on Round Die.

The die is set in the centre and held perpendicular, while more bone pieces are tightly packed round the die and covered 1 inch or so over the top. The pot is then placed on a heavy grid with a coal fire underneath, which should be well looked after to ensure a steady heat being maintained. According to the size of the die so will it be a shorter or longer time in coming to almost a white heat, but from $2\frac{1}{2}$ to 3 hours should suffice.

If case-hardening is done by gas it is advisable to have an air blast, which is much quicker, and with gas at a reasonable price it is more economical than a coal fire and gives a steadier heat.

Dipping the Die.—The pot is withdrawn to the front of the grid and the die removed from the pot with a pair of tongs. At this stage it should be seen that no cold blast of air strikes the die as it is being lifted from the pot to the cooling tank. The die should be plunged into the oil in a perpendicular manner and well tossed about for two or three minutes, because if taken out too hot it is apt to "go back" a little and become too soft to raise a good mill.

It is always advisable to test dies and mills after coming through

the hardening process by drawing a file across a part of the pivot to see that they are sufficiently hard. If a die happened to turn out soft and was not tested, the engraving might be ruined in the process of clamming before it was discovered. If soft, it can be again placed in the pot and hardened.

Oil for Case-hardening.—This ought to be well salted; a cheap compound of whale oil suits the purpose. As evaporation takes place, the oil must be added to frequently as a large quantity should be maintained, especially for dipping large dies or mills.

Flat dies are placed on the perpendicular—not flat—in iron boxes, and surrounded with bone pieces, then placed on the grid and brought to almost a white heat; it is afterwards removed from the box and dipped in the same manner as explained for round dies. Mills also are hardened and dipped like round dies.

Re-using Old Dies and Mills.—From an economical standpoint it is well to again utilise dies and mills that have been lying aside for five years or more; beyond this period there is usually a great quantity that are not likely to be used for repairing or re-engraving. These tools can be softened and turned down for smaller sizes, thus saving not only the cost of new material, but also a great amount of time in "roughing out," which takes place with new iron.

Softening Old Dies and Mills.—To re-use these tools, it is unnecessary to place them in pots for this purpose. They are usually laid on the top of the grid until they become cherry red, then withdrawn and allowed to cool.

Clamming Machine or Clams (see fig. 219).—This machine is used for the purpose of transferring the intaglio engraving on a case-hardened die to a soft steel cylinder in relief or cameo, which is called the mill.

The clams are built on the principle of a powerful screw press. A A is the cast-iron frame; B, a headstock screwed on to the framework; and C, a sliding piece capable of movement on the headstock. The back bowl D revolves in bearings attached to the sliding piece C. The supporting piece E has a motion backwards and forwards on an under supporting piece which can be moved backwards and forwards by turning the screw handle F, up and down with the screw handle G, and fastened with screw handle H. The level of this supporting piece, when shifted, should always be tested with a spirit level. I is a small auxiliary steel roller which again supports the die J. The mill K revolves in bearings attached to the headstock; this headstock has a sliding movement on the slide block L, which is moved from left to right by the screw M, and turned by the cross

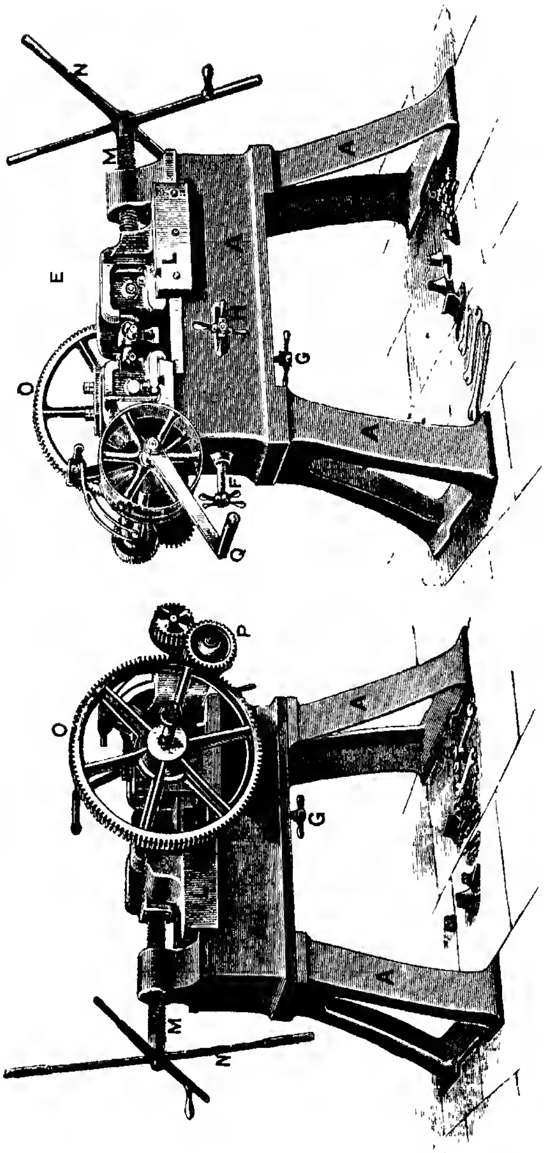


Fig 219.—Clams Back and front view.

handle N. O is a spur wheel geared into a small pinion P, and turned by the winch handle Q. The shaft R has a sliding movement through the spur wheel O, and carries the driving nozzle; this has a square aperture to receive the centre of the back bowl, which is squared so as to fit into the nozzle. The driving nozzle gives a true drive to the mill, even when the driving shaft is not exactly central with the mill. The fast and loose pulleys S and T give the power drive.

The die, as already mentioned, usually has one repeat or sketch on the circumference. The mill, however, requires several sketches or repeats on the circumference for two reasons:—1st. To make it larger and more practical for working. 2nd. Should a defect be on one of the repeats, the others being sound will make good the defect while running in the mill engraving machine. An exception to this rule always occurs with designs having two or three repeats on the roller, when the best must be made of one repeat on the mill.

The question, therefore, arises as to which is the most suitable number of repeats to be placed on the mill. In deciding this, one important point must never be overlooked—viz., the advisability (when convenient) of having an odd number of repeats, thus allowing the sketch to be interchanged during the process of machining.

The following table shows the number of sketches usually raised on the mill:

Designs	On Dies	On Mills.
2 repeats in circumference of roller, ...	1 sketch	1 sketch
3 " "	"	1 "
4 " "	"	2 "
5 " "	"	2 "
6 " "	"	2 "
7 " "	"	3 "
8 " "	"	3 "
9 " "	"	4 "
10 " "	"	3 "
11 " "	"	4 "
12 " "	"	5 "
13 " "	"	4 "
14 " "	"	4 "
15 " "	"	4 "

Roughing Mills.—According to the number of repeats to be placed on the mill, so is its circumference a multiple of the die, and the size of steel used varies accordingly. The mill also requires to be longer than the die, as a pivot at each end of the body is required. When finishing the body of the mill it should be shaped convex (as shown

in fig. 220), thus fitting as nearly as possible into the shape of the die, although during the process of clamming the finished shape will become the reverse of the die.

For large mills it is always advisable to have the $\frac{1}{2}$-inch diameter pivot instead of the $\frac{3}{4}$-inch size. When machining it allows the mill to run sweeter, there being less drag.

A centre is drilled on each pivot and the body rough-turned to near the size required, the pivots turned to the gauge (see fig. 221), which also fits the various mill steps used in the engraving machine.

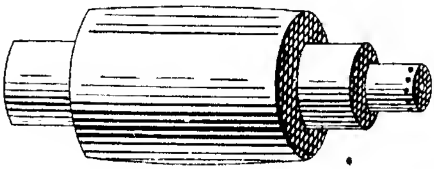


Fig. 220.—Mill showing Convex Shape.

Raising the Mill.—When a mill is about to be raised from a round die, say, of 10 repeats or fewer on the circumference of the roller, four cylinders are brought into requisition. The die No. 1 is inserted in the centre, resting on the top of the small auxiliary roller called No. 2. No. 3 is the back bowl against which the hardened die rests, and No. 4 in front is the soft mill (see fig. 222). The mill is then lightly pressed against the die by turning the cross handle N (fig. 219),

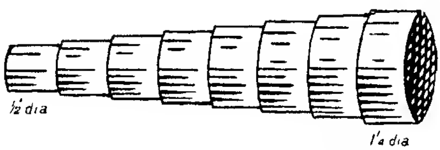


Fig. 221.—Pivot Gauge. Half size.

and is slowly revolved by the aid of a box key screwed on the pivot of the mill.

If the die is arranged for more than 10 repeats on the circumference of the roller the auxiliary steel roller is dispensed with and the saddle support (see fig. 223) inserted on the top of the under supporting piece. It should be noted, however, that it is not advisable to make dies with more than 16 repeats on the circumference of the roller, owing to the difficulty of raising a good mill therefrom, and, further, to avoid the liability of twisting in the process of case-

hardening, owing to the small diameter. In these circumstances it is better to place two repeats on the die.

The mill is now examined, and the sketches also measured with dividers to see that each repeat is equal. This is a most important point to observe, otherwise there might be long and short sketches, which would not traverse while running in the mill-engraving machine. If the sketches are unequal, the face of the mill must be cleaned with a fine file and tried again. More pressure is applied, and the surface of the mill covered with wax, which now brings out a relief impression. The mill is removed from the clams (the box key acting as a handle), and dipped into a vessel of weak nitric acid. The relief part in wax is thus protected, the acid etching the surface slightly. The mill is, thereafter, again placed in the clams and further pressure applied. The belt drive can now be used in place of the hand. Further etching must be resorted to by way of assisting the intaglio engraving on the die to be brought fully into relief.

When raising the mill it must never be overlooked that most of

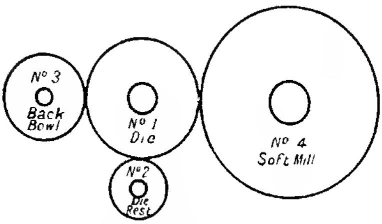


Fig 222.—Position of Mill and Die when Clamming

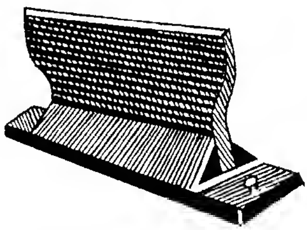


Fig 223.—Saddle Support used when raising Small Round Dies

the relief engraving is brought out by the frequent use of the nitric acid. If too much pressure is used the engraving will be brittle and may chip during the process of machining.

The mill is then placed into the turning lathe, and the "snags," which are also standing out in relief, turned off, leaving the relief engraving alone on the body of the mill.

Paring the Mill.—The mill, previous to case-hardening, is examined, and all false marks pared away with a flat-belly graver. In doing this, care must be exercised that no slips are made with the graver, otherwise the mill might be ruined ; also, when paring, that the cuts are not under the surface. The surface, where parts "box" at the joinings, requires to be scraped to prevent sinks on the roller. The mill is then ready for case-hardening.

Re-pressing, or re-sinking as it is sometimes termed, is done with a view to economise in diemaking. A large *ombrè* stripe can be run down on a die (see figs. 179 and 180), the outline of the flower traced on the top and the die snagged, then hardened, and a mill raised

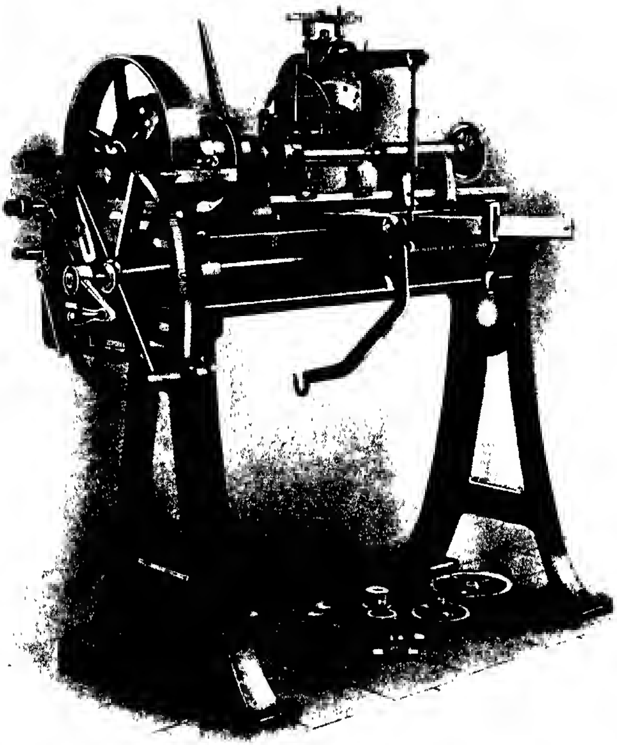


Fig. 224.—Re-pressing or Dividing Machine for Dies.

therefrom. The relief part inside the flower is now pared away (see fig. 181). Owing to the impossibility of paring it perfectly level with the surface, re-pressing the mill into another die is resorted to, thus

avoiding sinks on the roller. This new die will give a perfect surface and thereby enable a superior mill to be raised from it.

Re-pressing (see fig. 224) is also resorted to when a small part of a pattern can, with advantage, be raised and repeated by re-pressing it to the desired width and a mill raised therefrom.

Marking On for Traverse Work.—This is a most difficult thing to do successfully, and requires the greatest accuracy when running the pin on to the die, on which the diemaker has to work out the pattern (see fig. 187). Each of the sketches must link sweetly and no force applied to join on the circumference, otherwise trouble will ensue during the process of machining.

Raising Mills from Flat Dies (see fig. 225).—The mill in this case is prepared not with a view to being repeated in the circumference, but to allow, at least, ½ inch space between the sprigs to be raised.

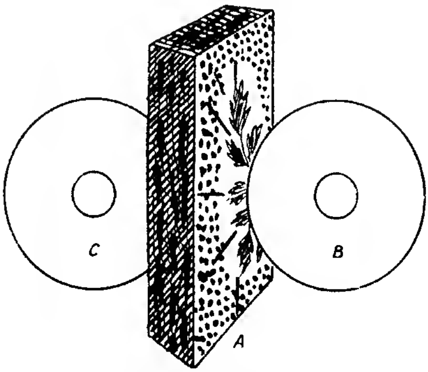


Fig. 225.—Raising Mill from a Flat Die.—A, the die (hardened); B, the mill (soft); C, the back bowl

The saddle is dispensed with and the flat die set against the back bowl of the clams (see fig. 219), care being taken that the position as marked is exactly on the square. The round mill is then brought into contact with the face of the flat die in the same manner as when raising from a round die. The winch handle is now turned backwards and forwards to suit the length of work on the die, more pressure being applied, wax used, and the mill dipped in acid; again set in the clams, and the handle turned until the engraving is fully brought out in relief.

It will be observed that in raising mills from the flat die, the belt power cannot be used ; the rotary motion being restricted. The winch handle can only be employed to suit the size of the die.

For the other positions the die is turned round to the required square and the mill also set accordingly, and the method repeated of bringing out the engraving in relief.

The snags are now turned off and the mill examined by the die-maker previous to case-hardening, which is done in a similar manner as explained for dies.

CHAPTER XVII.

MILL MACHINE ENGRAVING FOR GARMENT AND HANDKERCHIEF ROLLERS.

THE preparing of the tools for this method of engraving, as explained under Diemaking and Clamming, is rather expensive, but the advantage of transferring the relief work on the surface of the mill on to the roller with the rotary motion compensates, to some extent, the initiatory expense.

Description of the Machine.—Fig. 226 represents Moulton's Top Pressure Mill Engraving Machine, and is suitable for straight round, spiral, and cross-over work. It is built very strong and heavy, the bed A alone weighing from 12 to 13 cwts., but all this strength is required when consideration is given to the immense pressure that may be applied by the system of compound leverage to impress certain classes of engraving on to the surface of the rollers. A strong, deep-cut screw shaft runs the length of the machine in the centre of the bed, and at the right-hand side is fixed the grid B for setting up wheels for gearing, and on the screw shaft is set the 360-toothed wheel C with pitch finger and pointer. On the left the large wheel D or driving pinion is connected with the mandrel, and gives the drive to the roller E. Behind this large wheel are the driving pulley arrangements for the open and cross belt with a strap-shifting apparatus, which allows of the three pulleys being one width so as to give the reverse motion for the machine when required.

The side-shifting wheel F in front of the bed enables the workman to shift the carriage G sideways without going to the end of the machine. The circular canting mill frame H is carried in a steel lever I and balanced by the chain and suspended weight J.

The steel mandrel K runs in brass bushes, and on this is screwed the index wheel L, the face of which is accurately divided into pitch holes in order to secure any required division. On this wheel is also fixed the pitching arm M with screw arrangement N at the top for slashing when required.

The roller E is adjusted true on the mandrel with the split cones

and collars O. The bearers P P, on which the roller rests, are of hard wood on the top, inserted into a strong screw, and can be adjusted to suit the height of the roller or moved across the rail Q, according to the length. When the roller is in motion the ball weight on lever R can be moved outwards to increase the pressure on the roller as required.

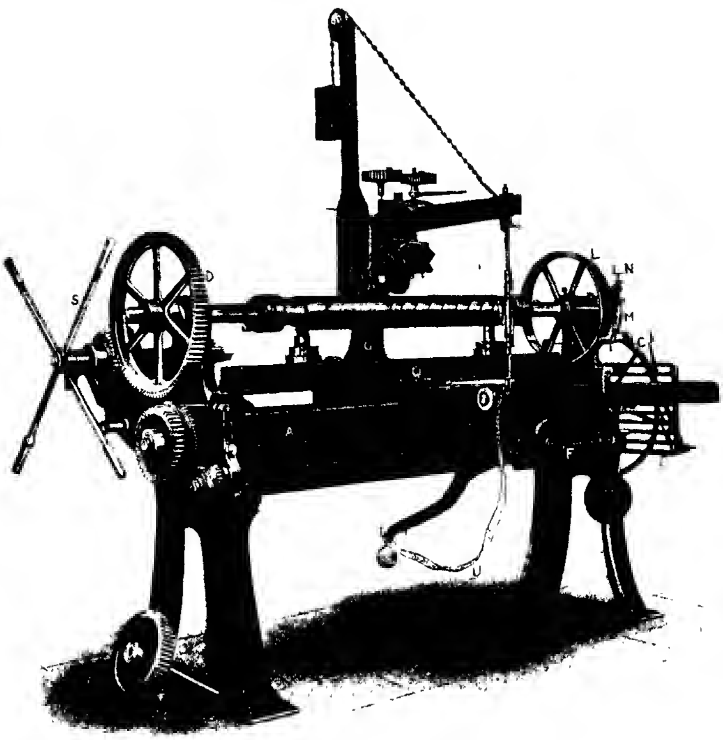


Fig 226 —Moulton's Top Pressure Mill Engraving Machine

The large cross S can be screwed to a short shaft on which is a small pinion wheel that can be moved into gear with the large wheel D when hand rocking requires to be done.

Attached to arm T and suspended near the floor is a leather strap U, which is most convenient for the engraver setting his foot upon,

to slightly release the mill from the surface of the roller when adjusting the pitch pin into the required position.

Mill engraving machine with patented end-driving motion (see fig. 227). This machine is similar in construction to the one represented in fig. 226, but is specially suitable for works where machines are better placed at right angles to the shafting, giving practically

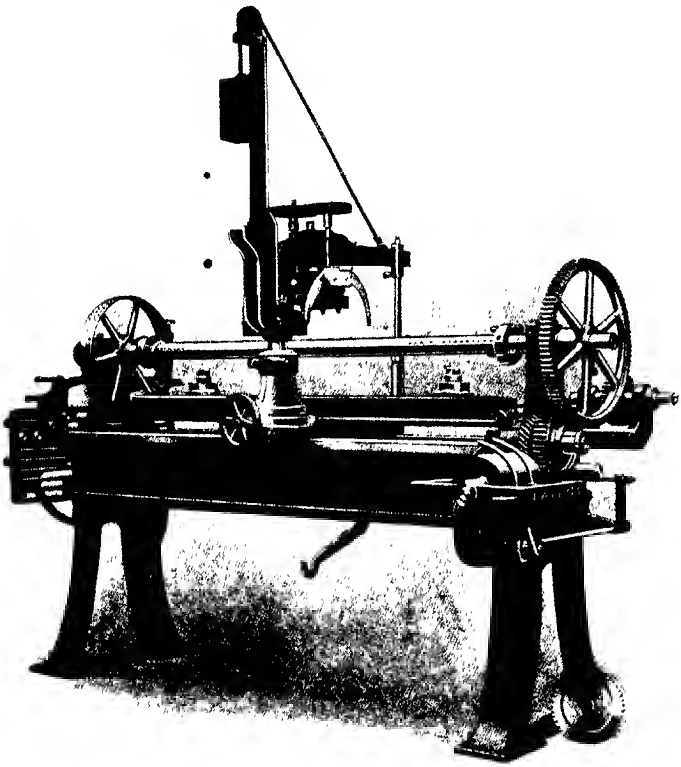


Fig 227 —Mill Engraving Machine, with patented end-driving motion.

a silent and smooth running drive, by open and crossed belts for reverse driving through a pair of machine-cut spiral and ordinary gearing, thereby doing away with the old objectionable noisy bevel gearing. The wheel on the screw is geared direct with the driving pinion, the mandrel being driven in a similar way.

To set the machine working in a reliable manner three points require special attention :—1st. To ascertain that the mandrel is perfectly level with the bed of the machine. This can be tested with the aid of the spirit level ; if it is not level the bushes can be packed accordingly. 2nd. See that the carriage is firm, but not too tightly screwed on the bed. The screws for this purpose should be tried occasionally. 3rd. The roller must run perfectly true.

Setting the Roller on the Mandrel.—The large pinion wheel is taken off and the mandrel raised from the bush (at the same end). A wood block is then placed on the top of the bush to prevent the roller being injured while it is being slipped on to the mandrel (wide end first), where it is pushed on to a cone, set in three sections, and held together with a ring. Another similar cone is slipped on at the narrow end and placed inside the roller. The collar is then fixed on the mandrel. The three side screws are now temporarily tightened, and a square with a point at the top set across the bed of the machine and the roller gently turned round. The cone sections are further screwed into the roller as required, until it runs true to the mandrel. Each of the ends are adjusted in the same manner.

Squaring the Mill.—After the roller has been trued, a plain mill with a small body and long pivots (see fig. 228) is placed in open steps on the mill frame, and set lightly down on the roller while in motion. If the steps are off the square the mill will at once run to the one or the other side. The screw, in steps, is then adjusted until the mill runs in the centre.

Sizing the Mill.—With electro copper it is advisable to place on a spare roller kept for this purpose, and try. not only the run of the mill as regards the circumference, but also the repeat, should there be critical joinings.

This avoids burnishing out the false mill marks, and eliminates any risk of springing the copper on the electro roller about to be engraved. With solid copper this is not necessary, as great liberties can be used in burnishing out false mill marks.

Marking On.—This term is used when a section of the engraving on a mill is repeated all over the roller. A special machine can be had for this purpose, and in a workshop where a large number of men require to be kept going it is most useful for dividing up work to attain this object. All straight round patterns can be first marked on, rollers taken off and passed on to the other machines for running up.

In lieu of this machine for smaller shops, marking on can be done with the ordinary mill machine in the following manner :—The side

shift is arranged as explained for straight round work, and a finger clutch fixed on the pivot of the mill, and placed against the mill frame. The pitch point is placed in the first of the chalk division lines, the mill rested on the roller, and the finger clutch swung out horizontally. The boy at the end of the machine then makes a short rock (according to the chalk lines marked by the engraver) by placing in gear the cross, and working it backwards and forwards several times. The mill is then raised from the surface of the roller, which is turned round and pitched in No. 2 chalk line, the clutch raised, and the mill again rested on the roller. The rocking is repeated, and so on, until the number of repeats on the circumference of the roller are completed.

At this stage the engraver can run the mill round the roller and connect up the engraving in a complete manner, as each side shift is marked on, or finish the marking on right across the roller previous to running up. When starting to connect up the "marking on," it is advisable to gently turn the roller to see that the mill comes in exact to the repeats already marked on. If the mill travels "large"

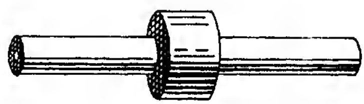


Fig. 228.—Mill used for squaring the Steps.

of the repeats it can be assisted back with the hand, or by the aid of a key on the pivot. Continue turning the roller with the hand for two or three revolutions, then set the machine in motion, and apply pressure gradually.

Well-sized Mills.—What is termed a well-sized mill for all kinds of "straight round" patterns is when the mill runs about $\frac{1}{16}$ an inch larger than the circumference of the roller, so that when the mill is thoroughly "bottomed" it will give sweet and clean engraving. The only exception to this is in line work, when the mill should repeat exact in the circumference.

If the engraving is scattered and of a light nature the open spaces are sometimes scratched on the die with a diamond point. This gives a certain amount of grip for the mill, but with all this precaution it will invariably be found more advisable to "bump" this class of work to obtain the best results.

Straight Round Work.—One design on roller. The term "straight round" is for work which repeats on the circumference of the roller

in a straight line and requires no gearing (see fig. 229). To continue the repeat across the roller resort must be had to the 360-tooth or standard wheel for what is termed the side shift or side repeat. The side distance would be taken from the repeat on the die with spring dividers, and this division set out across the roller solely for the purpose of dividing the work off in an equal manner at each end of the roller. This side distance is now adjusted from the standard wheel by so many turns and by so many teeth. If the pattern was of more than one colour, the mill showing the most critical joinings would be done first. Supposing the joining of the mill was on the square, chalk marks would be made on the index pulley for the number of sketches or repeats on the circumference of the roller. If half step, divisions would be marked at the half with a shorter chalk line, and when carriage was side shifted the chalk lines would be used alternately.

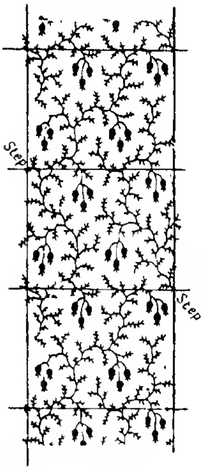


Fig. 229. Straight Round Pattern. Step half.

Two Designs on Roller (or splits).—These are proceeded with in the same manner as for one pattern on the roller, only it is compulsory to start from the centre and side shift towards the ends of the roller (see fig. 230). It is imperative with this class of work that there should be less "boxing"

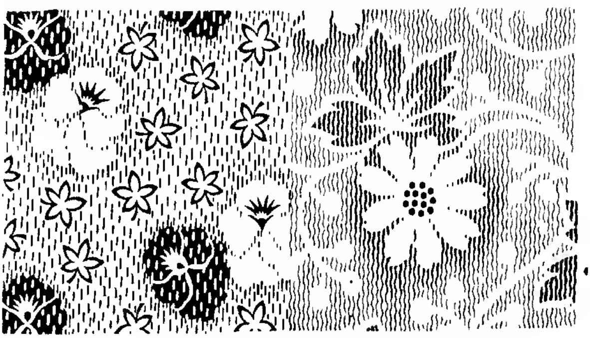


Fig. 230.—Two Designs. "Splits" on Roller.

at the joinings, and thus avoid gaps in the centre of the roller where the two patterns meet.

A transparent impression on waxed oil paper is taken from the first roller, and when one side of the other colour is engraved the impression is transferred to the roller fitting it with the side already done, and the other half commenced in accordance with this impression.

Canting the Mill.—As already explained, the mill is convex, and the machine engraver takes advantage of this to "cant" the mill by turning the wheels at the top of the mill frame the required amount and fixes the wheel clutch accordingly, so that each repeat will receive the same amount of "cant." After running on the centre, the mill is "canted" first on the one edge, then on the other, gradually increasing the pressure on the surface of the roller by moving out the weight on the lever.

Burr on the Roller.—When the mill has been run all over the roller, the parts of the engraving with solids show much stronger than the fine parts. These solid parts raise more "burr"—*i.e.*, copper being forced above the surface of the roller and preventing the finer parts getting down on the surface. The roller is now taken off the machine and polished, and again placed on the machine. The mill is entered into the engraving by the aid of the pitch pin, and run with the belt power. More weight can also be applied, which will now show the engraving more equal on the roller, but still more "burr" will appear. The roller is again polished and gone through for the third, or even the fourth, time, if necessary, until the work on the mill is thoroughly bottomed. This will be shown by all the surface of the mill being thoroughly clear and polished by running in contact with the surface of the roller.

Slash.—Designs with straight lines across the roller are usually slashed on the die. The engraver then requires to catch up this slash by turning the little wheel at the top of the pitching arm an equal number of turns for each side shift. This apparatus is also invaluable for adjusting critical joinings that will not connect perfectly. One turn of this screw, right or left, when each sketch has been side shifted, has the effect of turning the roller up or down a line, thereby correcting the defect.

"Wobble" on the Mill.—When a mill rocks from one side to the other as it revolves, it is said to "wobble." It is caused by the pivots not being true to the body by having got slightly twisted during the process of case-hardening.

The clammer can sometimes help this by turning a little off the pivots, but if the defect is serious it is more economical to prepare a fresh mill.

"Lumpy" Mills.—If the surface of a mill turns out irregular

it is termed "lumpy," and will give no end of trouble to the engraver. The die is usually at fault and may arise from defective shape, and the defects are bound to be reproduced when raising the mill; or the material, by parts of the surface having "caved in" slightly during the process of case-hardening. If serious, it is better to have the die softened and rectified, or a fresh die engraved rather than have defective engraving reproduced on the roller.

Sinks.—These defects occur from several causes:—1st, The mill having been badly pared with the flat belly graver so as to leave sharp edges; 2nd, the engraver excessively canting the mill, with the result that false parts are marked on the surface of the roller; 3rd, the same defects would occur if lumpy mills were used.

When the roller is polished these parts show a dull colour, the stone not getting at them because they are below the surface.

Avoiding Sinks.—A judicious use of weak nitric acid brushed over the high parts (on the surface of the mill), when observed during the process of machining, will lessen this defect to some extent.

A small emery wheel is highly useful when contact with the work on the mill can be avoided. It planes off lumps very quickly and evenly, or for smaller parts a piece of carborundum can be used with advantage.

Erasing Sinks.—When the roller has received its final polish with a hollow Water o' Ayr stone the surface must be thoroughly clean. Should any dull parts or sinks be showing these require to be brought to the surface by touching them with paint of a very thin consistency. The roller is then run in weak nitric acid, the surface being slightly reduced thereby, and the painted parts protected. The roller is again lightly polished, which should have the effect of clearing away the sink, if the correct time in the acid has been judged. This is a point for careful observation; if too short it will not have the desired result when the roller is polished, if too long it will occasion trouble, as it will be necessary to finger polish the excess copper away.

A good safeguard in this case is to finger polish a small part at the end of the roller to ascertain if sufficient acid has been given.

Mill Marks.—Scratches are sometimes placed on the die with a diamond point across plain spaces between heads, with a view to prevent the mill from slipping during the process of machining. These show on the roller slightly under the surface, and sometimes require to be painted if the engraving on the roller will not stand sufficient polishing to clean them away. To erase them they are treated in the same manner as explained for sinks.

Covering Mill Rollers.—When engraving of a solid nature is on

the mill it occasions a vast amount of machining to thoroughly bottom them by running, and perhaps before they are judged satisfactory, they will get "scaly" and rotten—*i.e.*, the top of the ground breaks away. For moderate sized solids a run of the roller in sharp nitric acid will clear this away, and allow the mill to sweeten up the engraving with the next running. But for large solids the roller requires to be covered, as explained under Chapter XX. Judgment requires to be exercised by way of painting out finer parts and etching the heavier portions as desired. If only a few solid parts require to be assisted in this way, it is speedier to cut them out with a tooth graver.

"**Boxing.**"—This is the term used when a deviation from a

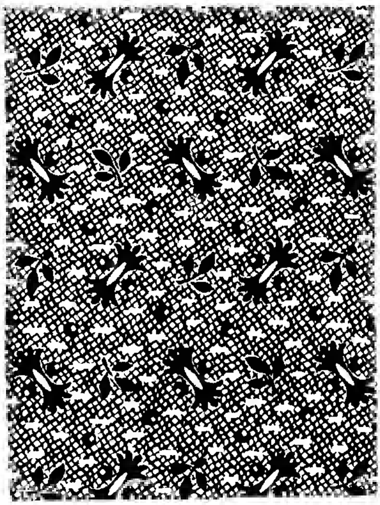


Fig. 231.—Style of Pattern suitable for "Link."

straight line in the circumference has to be made at the joining of the repeat so as to complete certain shapes (see fig. 229). It is advisable to have as little of this as possible so as to prevent an excess of sinks. The point for fixing joinings on mill patterns should, therefore, be well considered by the sketchmaker preparatory to placing the repeat on the plate.

"**Links.**"—This is a term used when a section more than the required repeat is engraved on the die. It is only practicable to adopt this method with one-colour patterns (as shown in fig. 231), and is done for the purpose of obviating defects at the joinings, which would undoubtedly stand out, if the repeat alone was placed on the die.

The engraver, when machining this class of work, does not require to arrange the side distance from the 360-wheel, but simply moves the carriage along when one sketch is run round the roller and fits the pitch pin on the link part into the pin on the sketch as he moves across the roller. When the roller is polished, and previous to going through the work for the second time, the link portion is turned away from the mill, and machined without the link. The same roller can be run up if the engraving gets worn down, but if re-engraved—*i.e.*, the same pattern done on a fresh roller—a new mill requires to be raised, owing to the link being taken away from the previous mill.

Preparatory to link mills being hardened it is a good plan for the diemaker to carefully cut away $\frac{1}{16}$ inch of the link next to the sketch, and thus avoid any risk of the turning tool touching the sketch when the link is being turned off.

Rocking.—With sprig patterns, or "bumps", as they are termed, and shown in fig. 216, it is impossible to run them up in a rotary manner, owing to the absence of any engraving between the sprigs to carry the mill round from one repeat to another. Resort must, therefore, be had to "rocking," by placing chalk marks, according to the amount of movement desired of the mill, on the large wheel at the driving end, or on the crescent attached to the mill frame with pointer fixed on the pivot of the mill. The lad for rocking stands at the end of the machine and turns the cross lever (when placed in action) backwards and forwards according to the chalk marks. The engraver alters the chalk lines to suit the parts of the engraving requiring special rocks, and places weight on the lever accordingly.

Rocking has sometimes to be done for certain parts of "straight round" work. Sprigs of a bold nature may be among the work that will run all right. Rocking would require to be done for the heavy parts to enable the finer portions to be thoroughly bottomed.

This system of hand rocking, on many occasions, is slow and laborious work. To overcome this inconvenience an appliance of wheel gearing for power rocking has been recently introduced and is likely to be extensively used in the near future.

Pressure.—The method of applying power so as to impress the engraving on the surface of the roller is done by moving and increasing the weight towards the end of the lever R, as shown in fig. 226. This system of giving pressure acts in a compound manner. Many hundredweights of pressure can be applied, so many indeed that were it not for the system of two circular bodies (the mill and roller)

revolving in opposite directions it would require immense power to drive it.

This pressure during machining has also the peculiar advantage of hardening the surface of the copper, thus giving it better wear, and is one of the many reasons why mill engraving is superior to pentagraph or hand work.

" Mocks."—The system of arranging " mocks " is usually done from patterns of a mottle character (as shown in fig. 232), so that a narrow sketch can be arranged from $\frac{1}{4}$ to $\frac{3}{8}$ inch broad, and three or five repeats

Fig 232—" Mock "

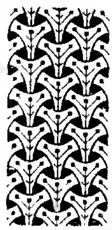


Fig 233 —Traverse Spiral

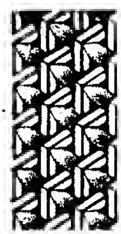


Fig 234 —Traverse Spiral

made on the circumference of the roller. It is invariably worked straight round. The mill is tossed or turned in an irregular manner for each side shift, to avoid showing a repeat across the roller, hence the name " mock." Before proceeding with a pattern of this description it is better to make a trial of the side distance and obtain an impression to make certain that all is in order, because one or two teeth of the wheel being too open will show a white, and if too close it will show a heavy part at the side joining. The test is, therefore, imperative.

Traverse.—All spiral work must traverse, and this term is used where similar units are made to form a practical repeat. The details of the engraving on each of the units must fit into each other, and are said to traverse.

Spiral Work.—This method of mill engraving is the speediest known. It is named from the engraving on the tool running in a continuous spiral line from one end of the roller to the other. Repeats up to about ¼ inch broad can be done in this manner (see figs. 233 and 234). When broader they must be done as straight round, but they can be linked across the roller.

All traverse mills of a large repeat nature, if intended to be run spiral, should be tried on the roller previous to it being turned off. The exact amount can thus be marked and the roller suited to the mill. Electro-plated rollers are, therefore, not so suitable for this class of spiral engraving, although it can be done with small repeats or checks, as shown in figs. 235 and 236.

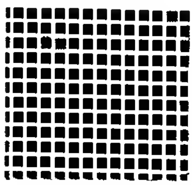


Fig. 235.—Check Spiral

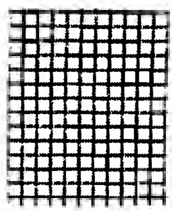


Fig. 236.—Check Spiral

Covers.—This class of work may be used for two styles of printing—1st. The roller completely covered with the small design (see fig. 237, A) and used with a roller of another pattern (usually a sprig) printing on the top of the cover (as shown in fig. 237, B). 2nd. The roller is engraved in the same manner, but the space saved for where the sprigs of another design have to drop in.

In this case the outline of the sprig is traced by pentagraph after the cover is engraved. The roller is now ready for electro-depositing. It is first thoroughly cleansed in the polishing lathe and laid on the painter's table without the fingers touching the surface, so that no grease or foreign matter will tend to arrest the deposit of copper. The ground portion is well gone over with paint, leaving the sprig portion clear. When the paint is thoroughly dry and hardened the roller is placed in a horizontal manner in a bath and electro-deposited

to the depth of the engraving, the copper deposit fixing only on the parts left clear—*i.e.*, where the sprigs have to fall.

The roller, when taken from the bath, is thoroughly cleansed and carefully polished with a saddle stone, which will leave the sprig

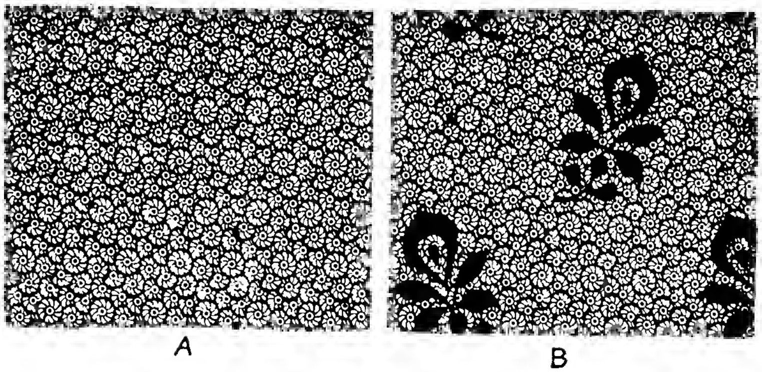


Fig 237.—A, Mill cover; B, pentagraph sprig falling on cover

portion clean and clear (as shown in fig. 238, A), also on a level with the cover work.

A simpler method can be adopted if the cover roller is not too fine, yet admits of being pentagraphed as an all-over: then the outline

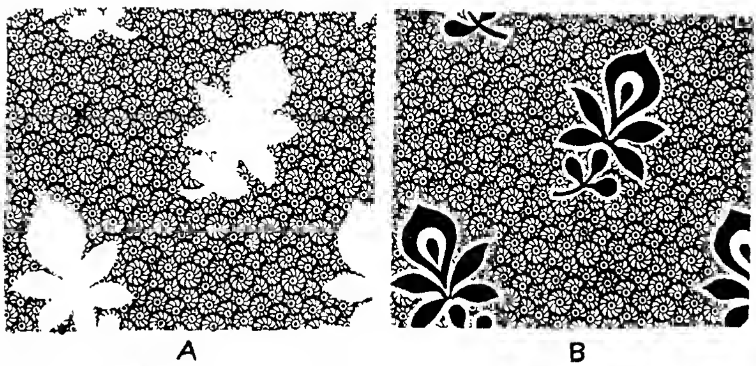


Fig 238.—A, Mill cover with whites of sprig copper deposited; B, pentagraph sprig fitted into cover

of the sprig is traced, while the inside of the sprig is painted away and afterwards etched in the usual manner, which allows the sprig to fit into position as shown in fig. 238, B.

Zephyr or Mild Effects (as shown in figs. 239 and 240) are done in two ways, either as a diagonal or as a cross-over check. Each of them requires exceptionally careful treatment by the machine engraver, as the slightest clouding will condemn the print.

The roller requires to be set perfectly true and to be well polished,

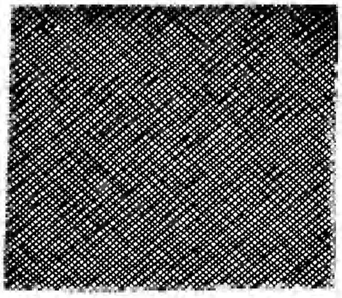


Fig. 239.—Diagonal Zephyr

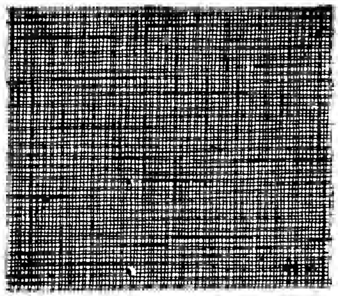


Fig. 240.—Check Zephyr

finishing with a saddle stone. Solid copper is essential; electro rollers are useless for this class of work.

The effect is usually worked up from a mill with a single line slightly waved in an irregular manner, and side-shifted according to the scale desired. It is always advisable to place it on a trial roller and to do a small portion; not merely to adjust the scale, but also

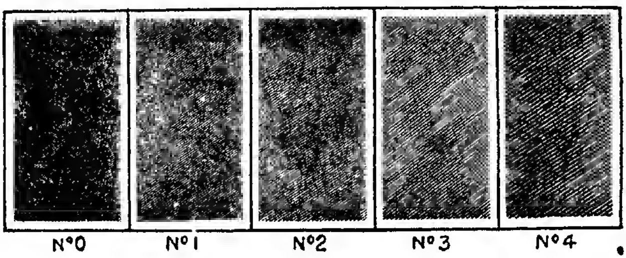


Fig. 241.—Various Scales of Pads for Tinting Cloth.

to decide the weight required. One angle of the line is then engraved and carefully polished with a saddle stone, and the roller returned to the machine for the crossing. Owing to this method being adopted it is advisable to give the first angle rather more weight as compared with the second.

Pads.—This engraving is used for "tinting" cloth in the printing machine. The rollers must be solid copper and well polished, finishing off with a saddle stone. The mill is simply a diagonal flat pin line made on various scales which are numbered from 0, the finest, up to No. 4, the coarsest (see fig. 241).

They are run spiral, and when the roller is completed it is only

Fig 242.—Eccentric Work

well brushed out with naphtha, washed, and dried off; on no account must a polishing stone be used.

The printer usually employs two rollers when padding, using a No. 1 and a No. 3: this method gives a flatter and sounder tint and enables the machine to be run at a greater speed.

Eccentric Work (see fig. 242).—This method of engraving is done

on a varnished roller by means of diamond points moved by very elaborate machinery.

The variety of patterns is the result of eccentric movements given to the points by a combination of wheels, hence the term "eccentric."

The exact effect that will be produced by any given modification of the machine cannot be determined, though an approximation can be made. But when a pattern is produced and notes taken of the relative position of the wheels, etc., the same pattern can be again produced.

CHAPTER XVIII.

WHEEL GEARING FOR MILL ENGRAVING MACHINE.

THE arrangement of the wheels is simple, alike for ordinary traverse or diagonal work, as for cross over, either with or without "slash" if certain principles are understood.

Divisional Wheel.—The 360-tooth divisional wheel is used as a standard, this being found the most suitable, owing to the greatest number of ratios capable of being obtained from it. The 60-tooth or "box" wheel, as it is termed, is the most suitable ratio for working into this divisional wheel, being a ratio of 6 to 1.

Examples of Ordinary Spiral Work.—With a 60-tooth wheel on mandrel and 360-tooth wheel on guide screw, note the position of these wheels, which is always the same for all kinds of spiral work.

Rule—

$$\frac{6}{\text{Revolutions of roller per inch of traverse of carriage}} = \frac{\text{Driver wheel}}{\text{Driven wheel}}.$$

Example.—Say 20 revolutions of roller per inch of traverse.

Apply rule—

$$\frac{6}{20} = \frac{36}{120} = \text{wheels required (see fig. 243).}$$

If required reverse, insert an extra intermediate stud and wheel.

The constant 6 is due, as already explained, to the gears 60 and 360, being a ratio of 6 to 1.

Spiral Work.—There are two kinds of spiral :—1st. Wheel driven with mill in tight steps, such as Bengal lines (see fig. 244) and spiral "mocks" joining edge to edge, so that the mill is carried across the roller accurately.

2nd. Traverse with mill in open steps, such as pads (see fig. 241) and traverse covers (as shown in figs. 233 to 236). These can be made to travel across the roller by an adjustment of the square of the machine. Wheels are geared up to keep pace with the traverse.

1*st*. *For Wheel-driven Spiral—Mill in Tight Steps.*—First, find wheel for side shift by using spring dividers and machine engraver's 360-tooth scale (see fig. 245). Each inch of this is divided into six parts, representing 60 teeth for each part, which gives 360 parts for each inch, equal to the number of teeth on the standard wheel.

For convenience of measuring the side distance some inches are

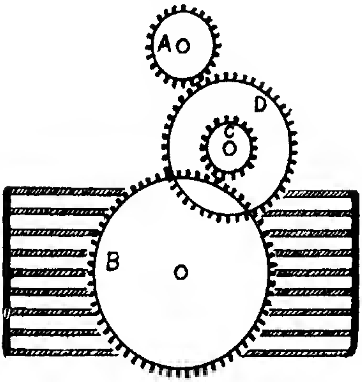


Fig 243.—Gearing for Spiral Work, Garment Rollers. A, 60-tooth wheel on roller mandrel; B, 360-tooth wheel on guide screw; C, 36-tooth wheel as driver wheel; D, 120-tooth wheel as the driven wheel.

subdivided into $\frac{1}{12}$ths = 30 teeth, and others into $\frac{1}{24}$ths = 15 teeth on the standard wheel.

Then from pattern, "rough" or oil-paper sketch, find side shift in teeth of 360-standard wheel. Then take any two convenient wheels as drivers and proceed to gear according to the following rule:—Any size of driver, either 60, 80, or 90-tooth wheels will do, but they

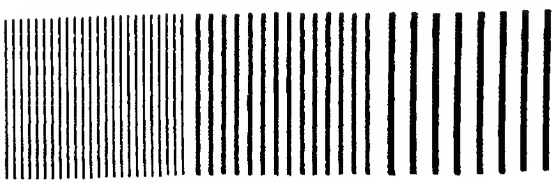


Fig 244.—"Bengal" Lines.

must have the same number of teeth to throw off. It is only the side shift wheels that count.

Rule.—Having placed the 360-wheel on the guide screw, take one stud and one socket and bolt on to the stud rail. Take two wheels of convenient size as drivers, place one on the roller mandrel, the other on the outside of the stud socket, with the wheel for side shift

into the 360. Say, 40 teeth was the side shift wanted, then the wheels would be

60 on roller mandrel.
|
40—60 on same socket as 40 (side shift).
| (the 60 outside, the 40 inside).
Screw mandrel 360

2nd. For Traverse—Mill in Open Steps.—The same rule as in the first method might hold good in many cases, but a wheel or wheels have to be found to keep pace with the mill. The engraver might find the wheel selected (the side shift) was too slow or too fast for the traverse of the mill as it crosses the roller. He would then require to adjust his drivers to suit, by reducing the one and increasing the other, until he found the pace as near as possible. Take a pad, for instance, running out two pins; to keep pace with the mill, slow gearing would be necessary. The side shift might be under 20 teeth, therefore the rule would have to be dropped and wheels found by experiment to keep the pace.

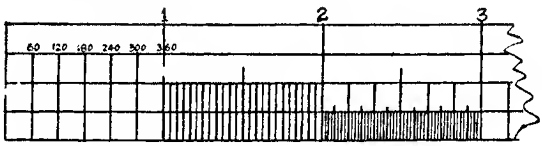


Fig 245.—Section of Machine Engraver's Scale. Actual size

This only applies to the traverse spiral. For the wheel-driven spiral the rule must be adhered to.

It can, therefore, be seen that the drivers (as in the case of a wheel-driven spiral) are only intended to make the side shift wheel to turn once for every revolution of the roller, and as this is the pace required for the mill to travel across the roller, only one wheel has to be found (the wheel for the side shift). Any size of drivers will do, provided they contain the same number of teeth.

Cross-over Work.—This term is used when the mill is run across the roller for either garment or handkerchief engraving. The mill frame requires to be turned a quarter, and so adjusted as to have the mill running true.

To gear spiral from guide screw with the 60-tooth wheel on guide screw and 360 wheel on the mandrel, it will be observed these wheels change places from that arranged for spiral work. The machine is thus driven by the screw instead of the mandrel.

Rule—

$$\frac{\text{Amount of slash} \times 6}{\text{Circumference of roller} \times \text{length of roller}} = \frac{\text{Driver wheel}}{\text{Driven wheel}}.$$

Example.—Say, slash $= 1\frac{1}{4}$ inches, circumference of roller $= 18$ inches, and length of roller $= 36$ inches.

Apply rule—

$$\frac{1\frac{1}{4} \times 6}{18 \times 36} = \frac{7\frac{1}{2}}{18 \times 36} = \frac{2\frac{1}{2} \times 3}{18 \times 36}$$

$$= \frac{25 \times 20}{180 \times 240} = \text{wheels required (see fig. 246).}$$

If required reverse insert an extra intermediate stud and wheel.

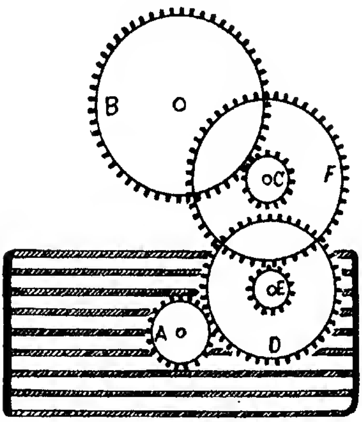


Fig. 246.—Gearing for Cross-over Slash Work Handkerchief or garment rollers.—A, 60-tooth wheel on guide screw; B, 360-tooth wheel on roller mandrel; C, 25-tooth wheel geared into 360; D, 180-tooth wheel geared into 60; E, 20-tooth wheel geared into 240; F, 240-tooth wheel geared into 20.

The constant 6 is due to the gears 60 and 360 being a ratio of 6 to 1.

The figures $\frac{2\frac{1}{2} \times 3}{18 \times 36}$ must be converted into suitable wheels by multiplying them by any number, one figure on the top line and one on the bottom, say, $2\frac{1}{2} \times 10 = 25$, and $18 \times 10 = 180$. We have then $\frac{25}{180} \times \frac{3}{36}$. Now 3 is $\frac{1}{12}$ of 36, or a ratio of 12 to 1, and a wheel of this ratio is now substituted for $\frac{3}{36}$. Twenty has been substituted, which multiplied by 12 gives 240, thus we have $\frac{25 \times 20}{180 \times 240}$.

Owing to the variety in the circumferences of the rollers, also the varying degrees of slash, the engraver must dispense for every-day work with the theoretical principle as explained, and proceed at once to utilise the three large wheels (other than the 360)—viz., 240, 180, and 120 teeth—and try small wheels between to catch up the required slash. These range from 20 teeth rising in units up to 105 to form a complete equipment of the machine.

To follow Slash of Pentagraph Machine.—To fix up gearing to follow the slash for milling of lines.

The object of this gearing is to secure a movement of the roller on the circumference to suit the slash simultaneously with the movement of the carriage across the roller. The slash is, therefore, a deviation from the square, as shown in fig. 70.

Rule.—Place the 360 (standard wheel) on the roller mandrel and 60 (box wheel) on the screw mandrel, then take two studs and fix them to stud rail (short stud first and longer stud second). Take their corresponding sockets and place on them two of the smallest wheels inside, with the 240 on outside of the first stud and the 180 on the outside of the second stud. Then with a third stud place wheels on the socket to find the slash or angle required.

The wheels might now be—

360-tooth wheel on roller mandrel.
30—240 (on first stud) the 30 geared into 360.
25—180 (on second stud) the 25 geared into 240.
40—120 (on third stud; the 40 geared into 180.
60 (box wheel) on screw mandrel geared into 120.

The 240-, 180-, and 120-tooth wheels are large convenient wheels for finding the slash.

On the first two studs the wheels are a fixture and are always built up in the same way, unless in exceptional cases, when the 25 wheel on the second stud might have to be increased or reduced.

The third stud alone is used to find the slash, the inside 40 wheel being increased or reduced by the engraver until the correct angle is found.

Reverse Slash.—If the roller shows the reverse slash, a dummy stud has to be inserted with one wheel to throw the gearing the reverse way. This extra stud may be fixed up between the second and third studs, or between the third and the 60-box wheel. Any size of wheel may be used, as it does not influence the gearing in any way other than to move it the reverse way.

Adjustment of Teeth.—It is most important when setting up

wheels for mill engraving to see that the teeth are not too deeply set into each other, otherwise they will not only make a noise, but are very liable to get broken. They can be readily eased a little by unscrewing the nut which binds the stud to the grid frame. A drop of oil will assist the wheels to run smoothly.

To find the Slash.—At the back of the carriage or mill frame a swivel point is fixed, having placed the point at the end of the line and marking it on the roller to indicate the point of start and running the carriage up to the other end of the roller. The point, if laid on the surface, will indicate the amount of slash thrown off.

If the wheels show a greater slash than the roller, the inside wheel on the third stud must be reduced, and if less slash is shown, it must be increased in size.

The wheel is changed and again tested until the exact angle is secured.

The engraver then proceeds to square the mill frame to the slash. This is done by the smooth burnisher having long pivots and placed in open steps. A long strip of zinc is placed across the roller beneath the burnisher to prevent the mill from injuring the surface of the roller. For this purpose a double strip of zinc is recommended for electro rollers.

By running the carriage up and down (with the wheels in gear) the mill frame is adjusted until the travel of the burnisher runs equal in the open steps.

The milling of the lines is then gone on with, lightly at first, then putting on sufficient pressure to put the mill on the bearers, giving strength and sharpness to the work.

With broad mill lines it is often essential, after the roller is polished, to go through these for the second time.

Divisions in Cross-over—no Slash.—If required to find wheels for divisions in cross over with no slash, two studs are only required, as follows:—

Rule.—Place the 360 wheel on the roller mandrel, then take convenient multiple for 360—viz., 30 and 12—and place the number of repeats between these figures, with any convenient divisional wheel on the outside of the second stud.

Example.—Say seven divisions were wanted, then the wheels would be—

360 on roller mandrel.
|
30—7 on first stud.
|
12—240 on second stud.

It will now be seen that as the 12 is on the same stud as the 240, if we turn the 240 seven times we turn the 12 seven times also, turning off 84 teeth in the process, and as the 12 is geared into the 7, 84 teeth are, in consequence, turned off the 7, which turns the seven twelve times, again the 7 being on the same stud as the 30 causes the 30 to turn twelve times. 12 times 30 being 360, you have gone right round the 360 or standard wheel or roller mandrel, giving seven equal divisions as wanted.

This rule, taking multiple for 360 and placing number of repeats wanted between, is the principle of the problem and must never be lost sight of.

To put the principle into practice we find there are no such wheels as have 7 teeth or 12. The difficulty of getting convenient wheels in place of them is soon got over by increasing the size of those wheels proportionately.

The following examples will show how the wheels can be increased to convenient sizes :—

(The small figures above the wheel indicate the power to which it has been raised.)

360-roller mandrel.	360-roller mandrel.	360-roller mandrel.
(4)	(8)	(10)
30 = 28 (7) 1st stud.	30 56 (7) 1st stud.	30 70 (7) 1st stud.
(4)	(4)	(5)
48 (12) 2nd stud.	48 (12) 2nd stud.	60 (12) 2nd stud.
1 turn off 240 for 7 times will throw off 7 equal divisions off 360.	2 turns off 240 for 7 times will throw off 7 equal divisions off 360.	2 turns off 140 for 7 times will throw off 7 equal divisions off 360.

It will be observed that the rule, the 30, the 7, and the 12 run through all these combinations, because the divisions could not otherwise be found. The purpose of raising the wheels to the 8th or 10th power is only to assist the third stud to get the angle or slash. Where no slash is required the first example raised to the 4th power will be found sufficient for all ordinary purposes.

Divisions in Cross Over—with Slash.—The engraver having set up the divisional wheels in the same manner for the first two studs, as already explained, now proceeds to build up a third stud to secure the necessary slash by first placing the 60 (box wheel) on the screw mandrel, and proceeds to place in wheels, as for slash finding, until

wheels for mill engraving to see that the teeth are not too deeply set into each other, otherwise they will not only make a noise, but are very liable to get broken. They can be readily eased a little by unscrewing the nut which binds the stud to the grid frame. A drop of oil will assist the wheels to run smoothly.

To find the Slash.—At the back of the carriage or mill frame a swivel point is fixed, having placed the point at the end of the line and marking it on the roller to indicate the point of start and running the carriage up to the other end of the roller. The point, if laid on the surface, will indicate the amount of slash thrown off.

If the wheels show a greater slash than the roller, the inside wheel on the third stud must be reduced, and if less slash is shown, it must be increased in size.

The wheel is changed and again tested until the exact angle is secured.

The engraver then proceeds to square the mill frame to the slash. This is done by the smooth burnisher having long pivots and placed in open steps. A long strip of zinc is placed across the roller beneath the burnisher to prevent the mill from injuring the surface of the roller. For this purpose a double strip of zinc is recommended for electro rollers.

By running the carriage up and down (with the wheels in gear) the mill frame is adjusted until the travel of the burnisher runs equal in the open steps.

The milling of the lines is then gone on with, lightly at first, then putting on sufficient pressure to put the mill on the bearers, giving strength and sharpness to the work.

With broad mill lines it is often essential, after the roller is polished, to go through these for the second time.

Divisions in Cross-over—no Slash.—If required to find wheels for divisions in cross over with no slash, two studs are only required, as follows:—

Rule.—Place the 360 wheel on the roller mandrel, then take convenient multiple for 360—viz., 30 and 12—and place the number of repeats between these figures, with any convenient divisional wheel on the outside of the second stud.

Example.—Say seven divisions were wanted, then the wheels would be—

360 on roller mandrel.
|
30—7 on first stud.
|
12—240 on second stud.

CHAPTER XIX.

EMBOSSING OR RELIEF ENGRAVING FOR VARIOUS TRADES.

The art of embossing is somewhat apart from ordinary calico engraving, but several of the larger establishments have linked up this business with their calico trade, not only to supply the limited demands required for the cloth, but also the larger business in connection with various cylinders for embossing paper, leather, and glass.

Schreiner Finish for Cloth.—Certain cloths, when ready for finishing, instead of being run through the plain calender bowls are pressed through a Schreiner bowl—*i.e.*, an engraved steel bowl to impress on the surface of the cloth a fine cord, giving a lustre. This effect may be engraved either on the angle, straight across, or straight round. The lines engraved on the steel bowl may run from 150 to 250 lines to the inch, according to the finish desired. The microscopical exactitude required for the production of the die, also the raising of the mill, will at once be observed. Mill iron for such embossing tools must never be thought of, but only the finest steel used.

To carry out this class of work successfully, several special machines are required, such as the polishing lathe (shown in fig. 247) and the milling machine (in fig. 248). This is owing to the mild steel cylinders on which the engraving is done being entirely different from the copper rollers, having no bores through them, but heavy pivots instead.

They are of solid steel and from 40 to 60 inches long by about 20 inches in circumference, and may weigh from 12 to 30 cwts. The spindle, which rests in the bushes of the machine, is also turned out of the solid. The surface, when turned and polished, must be free from any blemish. The machining must also be carefully done and show no cloud markings of any description.

Velvets.—Great depth of engraving is required for embossing velvet. The pattern must be deeper than the "pile" of the cloth, so that when it is crushed over the cylinder the pile of the velvet on the parts showing the pattern remains upstanding and the ground flattened.

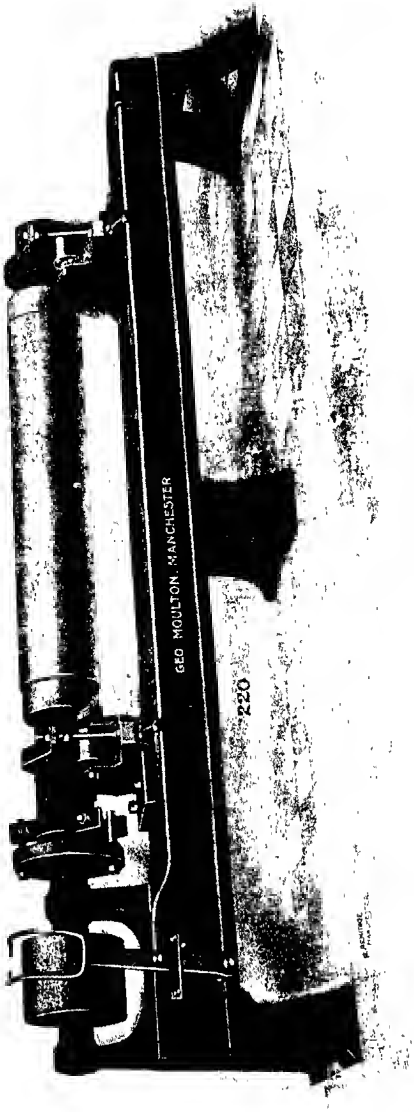


Fig. 247.—Polishing Lathe for Steel Bowls

For embossing of this description the intaglio parts are cleared out with a "routing" machine. The outline of the design would first be engraved, and the router or drill of the machine applied for cutting out the metal as required.

Crepe Cloth.—In connection with ladies' attire this also goes through rollers to give it the required "crinkle." The engraving is not so

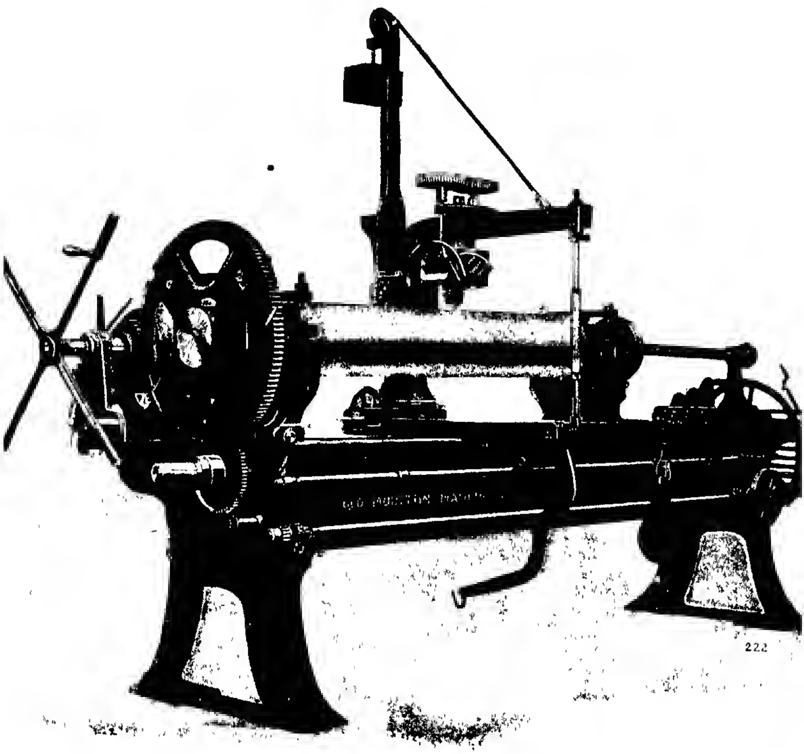


Fig 248—Mill Engraving Machine for Steel Cylinders.

deep as for velvet, but sharp edges must also be avoided, as these would have a tendency to cut, and thus damage the cloth. The frequent use of nitric acid, by covering the cylinder with varnish and etching the engraving deeper, saves an immense amount of time in the process of machining.

Paper.—This class of work may be divided into two classes :—

1st. Embossed papier-maché for decorative panels on the walls of public buildings (see fig. 249) or roofs of railway carriages, which requires engraving as deep as employed for velvets. 2nd. The finer class of paper used for confectionery boxes or other purposes. For this purpose dies are engraved for the small repeat patterns, mills raised, and the machining done in a manner similar to that explained for calico. For large repeats, such as "murie" effects, the ground line is first run over the cylinder and a punch applied on the line by the hand engraver to show the lustre effect, so that instead of metal being taken away, it is crushed down, thus giving a much better lustre. Sharp edges, that would have a tendency to cut the paper, must be avoided.

Fig 249.—Section of Decorative Panel (embossed)

Leather.—Various engravings are done on the cylinder to imitate the different "grains" of leather, as also a variety of skins. Those effects may be embossed on genuine leather, or leatherette, a kind of imitation leather for a cheap class of goods. Dies are engraved, and mills raised for this class of work, which are very expensive, owing to the amount of labour expended in producing them. They, however, are invaluable for reproducing repeat orders for these cylinders.

Glass.—For decorative purposes on windows and partitions this ornamental glass is extensively used. The designs are arranged in

such repeats as admit of them being engraved in a practical manner on the die. Many of them are also planned in a square repeat after the manner of floor-cloth, which admits of the glass being cut so as to form complete sections.

The engraving requires to be cut very deep, some designs as much as $\frac{1}{8}$ inch. It must also be a little deeper than is required to show on the glass, because the glass is rolled while in a soft state, and the pattern, being in relief, has a tendency to fall or flatten a little.

The engraving must have no perpendicular edges, but always

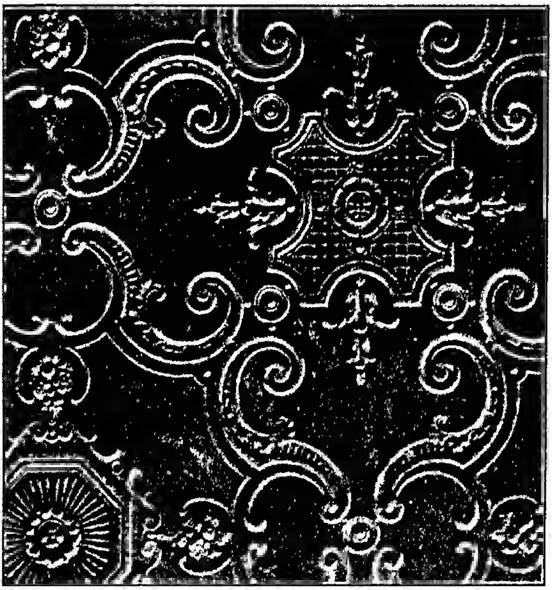


Fig. 250.—Embossed Glass showing "Shēne" Effect

be cut in the V shape, and be sharp in the bottom. The "shēne," as the light strikes the design at different angles, gives very pretty effects (see fig. 250).

It is customary when raising mills from the dies for all deeply engraved embossing work to produce three mills in different stages of finish—1st, only half raised; 2nd, two-thirds; and 3rd, the complete or perfect mill. They are also used in that order by the machine engraver, because, if the complete mill was first used and pressure applied to force it into the plain surface of the cylinder, the sharp

edges would all become chipped, and, therefore, spoiled for finishing purposes. No. 1 is first used, and having no sharp edges, great liberties can be used to further the engraving. The cylinder would then be polished and covered with acid-resist varnish as for calico, and then the rough engraving deepened with nitric acid. No. 2 mill can next be used with advantage, and the cylinder again deepened with the acid. No. 3, the perfect mill, is now used to sweeten up the edges and put the necessary finish into the engraving.

The preparation and working of the tools for embossing are so different from those used for calico, that special skill is really required by the artisans to make this trade a success.

CHAPTER XX.

ETCHING—INCLUDING VARNISHING, RULING, AND PAINTING.

By this process, in which a copper roller is etched by corrosion, it is first essential to give the rollers a coating with a resist varnish. The desired portions are scratched away, and then etched or bitten into by chemical action.

The fluid used for etching copper may be either nitric acid or a solution of perchloride of iron, or a judicious use of both ; thus, by beginning with nitric acid and finishing off by placing the roller in the trough containing the perchloride solution has been found to give the best results.

Nitric Acid, HNO_3.—This is received from the manufacturers in carboys, and as usually supplied has a strength of 84° Twaddle. This is far too strong, and would burn the engraving if used with this strength ; it is, therefore, diluted with water until reduced to a strength of about 65° Twaddle. Three parts of the strong acid to one of water usually gives the desired result. After reducing the strength of the acid previous to etching, it should be tested with the Beaume hydrometer (see fig. 251). This instrument is a glass float with a long tube on which the scales are marked, and can be used to test any solution heavier than water. It sinks in water to the point marked 0 on the scale, but rises in any denser liquid. The test is most accurately made when the temperature of the workshop is at 60° F. As it is inconvenient to graduate one instrument so as to suit all fluids, the hydrometers are differently graduated according to the fluids they are intended for.

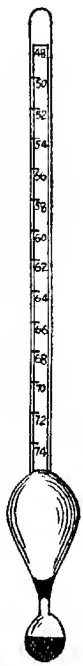


Fig. 251. Beaume Hydrometer, No. 3.

No. 2	registers from	24°	to 48°	Twaddle.
,, 3	,,	48°	,, 74°	,,
,, 4	,,	74°	,, 102°	,,

If no hydrometer is available the following table will be found useful and sufficiently accurate in making up the nitric acid :—

3 parts acid at 84° Twaddle and	2 of water	= 55° Twaddle.
2 ,, ,,	1 ,,	= 60° ,,
3 ,, ,,	1 ,,	= 65° ,,
Equal parts acid and water		= 68° ,,

Iron Perchloride (Fe_2Cl_6) is purchased in lumps, and is of a brownish-orange colour. As it absorbs moisture very readily it is advisable to place it in an acid carboy along with some water. When dissolved, more water is added until it registers about 45° Twaddle, at which strength it is used for etching.

Troughs (see fig. 252).—In a large workshop three sets of troughs are a great advantage. The arrangement of three troughs for the

Fig 252—Corner of Etching Room—A, etching troughs; B, washing-off troughs.

principal set is found to be most useful where partial etching with perchloride of iron solution has been introduced. This allows the trough with nitric acid to be at the back so as to be next to the draught which carries away the noxious fumes evolved during the process of etching. The perchloride trough is best in the centre, since no fumes arise when the roller is placed in this solution. These two troughs should be shallow, as shown in section in fig. 253, and should contain a limited quantity of acid which allows of their being cleaned out frequently; the frequent renewal of the acid is one important factor towards success in etching.

The trough for water is arranged in the front, and is provided with supply and outlet pipes. It is advisable to have this trough deeper than the other two.

No. 2 set should have a shallow trough containing nitric acid placed at the back next the draught and a deeper one for water at the front. This set is useful for part etching from the pentagraph machines as it avoids delay in work.

No. 3 set also has two troughs, both being deep. The back one would contain nitric acid "half spent"—*i.e.*, taken from the first set after getting too weak for etching sharp work. This strength of acid is suitable for use with rollers having a coarse ground. After being started in the stronger acid the roller is allowed to run in the weaker acid for a lengthened time to secure great depth. It is good economy to have a power drive to the etching troughs, especially the third set as the roller can be allowed to run while other work is being performed. Little power is required, so that a stout cord would suffice to drive it.

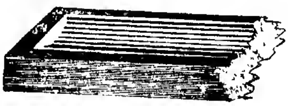


Fig 253.—Section of Etching Trough

Fig 254.—Step Block used on Top of Etching Troughs

These troughs should be set on a stone foundation and be level. They should also be true as far as possible, as any twist on them occasioned by firing at the pottery will cause the depth of acid to be unequal, and be a source of trouble by giving unequal etching. To overcome any difficulties arising from various circumferences of rollers, hard wood blocks are set on the top of the troughs, and for adjusting to the depth required a small step block (as shown in fig. 254) can be placed on the top and the spindle set in the desired groove.

Etching a Blotch.—It is imperative that rollers be set true on the spindle previous to etching, otherwise one part of the roller in the circumference will etch stronger than other parts owing to a greater volume of acid acting on the part which dips most. The roller having been previously prepared, as explained under varnishing and painting, nitric acid of strength 60° Twaddle is made up and well stirred in the trough. A heavy wheel is fixed on the spindle to give the roller

an impetus while turning, which must be done quickly—half a minute for fine grounds to one minute for coarse grounds is sufficient in acid; after which the roller is lifted out and turned in the water trough, which has the effect of not only taking away the action of the acid, but also of cooling the surface of the roller, which will be found to heat very quickly while in strong acid. The surface of the roller is now brushed over with a moderately soft brush, a jeweller's crest brush suits the purpose admirably. The etched line will now be shown to advantage. It is imperative that all blotches be brushed out after "breaking" in strong acid, otherwise the varnish will not show itself, stripping or breaking away when the etching is nearing completion. If great depth is wanted in the ground a run of twenty or thirty minutes in the perchloride solution, according to the scale of ground, will give the desired result. If ordinary depth only is wanted the roller is transferred to the slow nitric acid—*i.e.*, No. 3 set of troughs—and allowed to run. The roller must be lifted out occasionally and turned in water. This not only clears away any "scum" that may get into the engraving, but also has a beneficial effect in cooling the roller, and gives the opportunity of "trailing the scum," with a piece of rag, off the surface of the acid, and giving it a stir up with a glass rod used for this purpose. Before replacing the roller in the acid it is a wise plan to scratch a small piece of the varnish off at each end of the roller to ascertain if it is etching in a uniform manner. If it is not equal, this can be helped by raising the roller out of the acid at the end which is strongest, and gradually tapering off by lowering the roller down to the original level. Another way is to raise the roller out of the acid entirely and, while turning the roller round, gently pour acid from a jug over the weaker part until the desired equality is obtained.

Grounds under the Surface.—It is never desirable to allow a ruled ground to strip—*i.e.*, the varnish to break away, leaving the ground exposed. Any ground that has done this during the process of etching is under the surface, and, therefore, bad for printing. Previous to a ground being completed in the slow acid it is advisable to take it again to the No. 1 set of troughs and have it examined to see that the top is equal across the roller; if it is not, it can be "doctored" as already explained; if equal, a turn or two in the quick acid will bring the ground to the desired "top," which must be judged according to the nature of the work and also to the style of printing desired. Some printers require these blotch grounds better on the surface than others, but if a ground is much exposed in large masses to the action of the doctor in printing, it requires

to be better on the surface—*i.e.*, the top very slightly thick and not etched to a sharp point.

A blotch ground that is slightly under may be helped a little by a polish with a saddle stone, and may pass for printing; but one that, unfortunately, has been allowed to get etched much under is completely ruined, and requires to be engraved over again.

Mishaps in Etching.—Occasionally a mishap occurs during the process of etching a blotch, and the varnish on the surface will break away. It is better to stop the etching at once, wash the roller off, and have it recovered with varnish in the same manner as for a repair. The fine parts and outlines will require to be painted away. The roller can then be etched again as for an ordinary blotch, but without the start in the strong acid. Such a mishap may occur from several causes. The surface of the roller may have been tarnished by lying and not been properly cleansed previous to varnishing, or, having been etched in a cold atmosphere, both roller and acid may have become chilled.

Temperature of Workshop for Etching.—The best results in etching are obtained when the workshop is not less than 60° F., but higher than this is no objection. It must be remembered that nitric acid freezes at a higher temperature than water. This may be observed on a morning after a severe frost when the trough with nitric acid may have a sheet of ice over it, although there is none on the water. When making up acid under frosty conditions like this, it is advisable to mix a little hot water with the acid, and also to run the roller in tepid water previous to its being placed in the acid. Better still, avoid risk, and postpone the etching of rollers with elaborate and fine engraving until the temperature of the workshop has been raised.

Etching Ordinary Work.—The nitric acid in which two or three blotches have been "broken"—*i.e.*, first etched—suits this class of work admirably. The rawness of the strong acid has been taken away, and yet it is keen enough to give a level break for all classes of work other than blotches.

It must be noted that acid cannot be properly twaddled when once used. Experience alone tells when the acid becomes too weak. The rollers take too long a time to etch, and the blue colour indicates that the acid is becoming spent and cannot give good results. This acid should be transferred to the slow acid trough.

To etch rollers in acid too far spent is certain to give unequal results. Sketches of dumb or slightly weak cutting diamond points in the pentagraph machine take longer in being acted upon, and

these parts will show weaker than if etched with moderately strong acid able to penetrate from the beginning.

Etching Fine Work.—Previous to etching it is necessary to consider well the design and also to refer to the grounds on the instruction sheet. It may be observed at once that certain extra fine parts (as shown in fig. 255) are better stopped out by covering with resist paint and the etching further continued for the other parts. If acid requires to be made up for fine work, as shown in this figure, it is better to have equal proportions of strong acid and water. This will register about 68° Twaddle. After the roller has received a quick turn in this moderately strong acid it is transferred to the perchloride solution, which takes away the harshness that shows more or less on all engraving that has been etched with nitric acid only. This effect can be best observed when examined by the aid of the engraver's magnifying glass. The action of the perchloride

Fig. 255.—Parts marked A stopped out during Etching.

solution puts a depth and sweetness into the engraving which cannot otherwise be obtained. During the process of etching it is advisable to lift the roller out of the acid and to rub a small part of the surface varnish away at each end to ascertain not only if sufficient strength has been obtained, but also if the engraving is even. These parts are covered with resist paint, and etching further continued, if necessary.

Part Etching.—This method is adopted with patterns of larger solids which require two scales of ground. The roller is ready for a part etch after the pentagrapher has traced the coarse ground (see fig. 256, A), and should be placed in moderately strong acid. At this stage it is important to consider the coarse ground in relation to the finer parts of the engraving to be placed on afterwards and also the style of the pattern. If for discharge printing it is better

to be better on the surface—*i.e.*, the top very slightly thick and not etched to a sharp point.

A blotch ground that is slightly under may be helped a little by a polish with a saddle stone, and may pass for printing; but one that, unfortunately, has been allowed to get etched much under is completely ruined, and requires to be engraved over again.

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To etch rollers in acid too far spent is certain to give unequal results. Sketches of dumb or slightly weak cutting diamond points in the pentagraph machine take longer in being acted upon, and

solids be stripping too early it is better to go to the expense of painting them away rather than spoil the roller; or should the superpose effect be strong enough and the solid behind, it is better to delay a little to paint the shade away and to etch up the solids a little further.

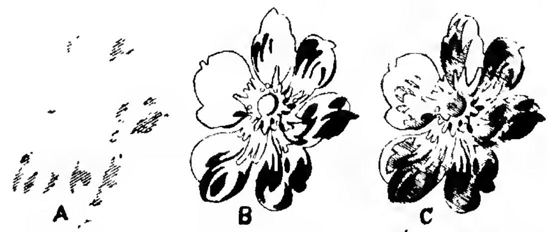


Fig 257.—A, First etching; B, second etching; C, third etching

Etching Pins.—When a design is principally composed of this class of work (as shown in fig. 258) and engraved by pentagraph, there are several simple but important manœuvres which add greatly to the finished result. First of all, it is imperative to have good clean and moderately strong nitric acid to give a clean break by speedy turning of the roller. Lift into the water trough and brush out, then

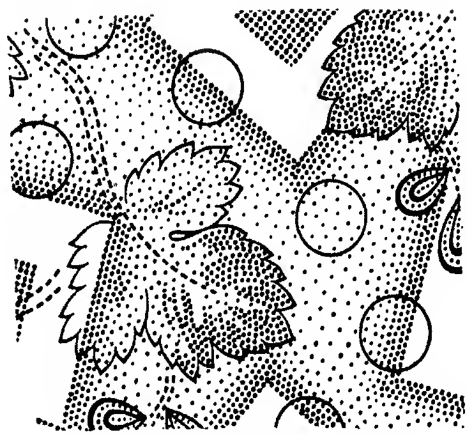


Fig. 258 — Pins Pentagraphed and Etched.

place back into the nitric acid, and give the roller several quick turns the reverse way. Lift again into the water trough and transfer to the perchloride solution to give a little depth and sweetness to the engraving.

Etching Checks (as shown in fig. 259).—It is important that the cross-over parts, especially with handkerchiefs, should be stopped out with resist varnish at an early stage, in order to maintain the lines better on the surface. This is equally imperative for very narrow lines on the circumference, because should they be etched deep the milling afterwards will simply put them into a hole and fail to furnish clean in printing.

It will thus be seen from the foregoing hints that there is great scope for good judgment in connection with etching, if the best results are to be obtained.

Washing-off Troughs (see fig. 252, B).—In all cases when etching is completed, the rollers are transferred to these troughs for cleaning off the varnish from the surface. The back trough is fitted in the bottom with a length of steam pipe to heat the water, and into this

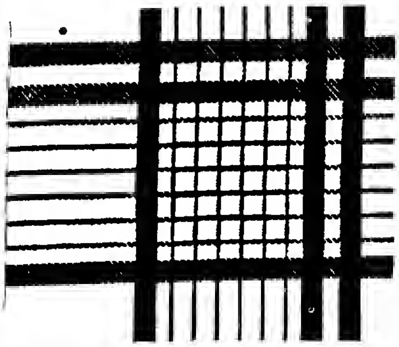


Fig. 259.—Handkerchief Lines forming Checks

trough is poured every morning a cupful of caustic soda. The roller is placed in the hot water and turned round for a minute or two, and a scrubber passed over the surface. The roller is then lifted out and turned in the other trough containing cold water; again lifted out, laid in front, and the spindle removed. Some places wash off with naphtha, but as this is "highly inflammable" the former method is recommended. The roller is then forwarded to the hand department for examination and finishing off.

Varnishing Machine.—The machine for this purpose (as shown in fig. 260) is of simple construction. At the top of the frame there is the spreading roller A. Underneath this is placed the copper roller B through which is placed a strong perforated tube C. (These two rollers are geared into each other.) The steam and water fittings

with the telescope joint D and tapered nozzle are connected with the perforated tube.

Towards the centre of the frame is the iron trough E with outlet discharge pipe F. The fast and loose pulley G gives the drive to the main shaft.

Dauber (as illustrated in fig. 261) is a large sized letterpress printers'

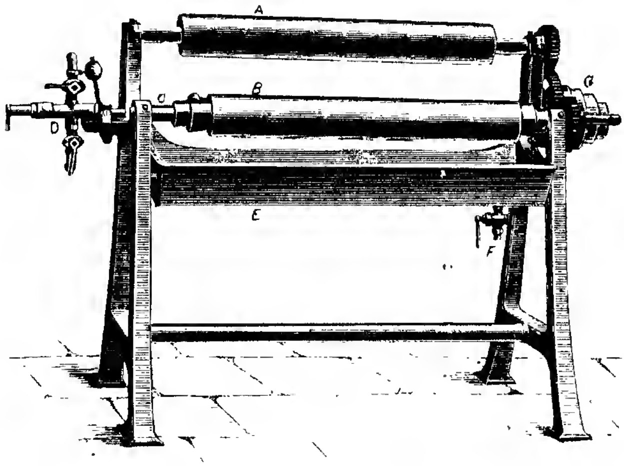


Fig 260.—Varnishing Machine

roller. It is placed in a hand frame and used for coating the rollers with various varnishes. They can be obtained from the makers in three degrees. viz. :—Hard, medium, and soft, and are made up with a mixture of glue, treacle, and gelatine. The modern system of casting these in workshops specially equipped for their manufacture ensures them being perfectly true, and is a great improvement on the

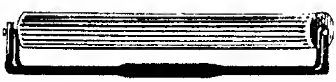


Fig 261.—" Dauber " for Varnishing Rollers

old system of an engraving shop casting them on their own account. The roller, if taken care of, by being regularly cleaned, and kept in a box when not in use, will last for years.

Varnishing.—Rollers for the pentagraph machine are varnished in the following manner :—The roller, having a well-polished surface,

is first placed on a tress in front of the machine. The perforated tube, which should be of the same diameter as the mandrel for ruling machine and etching troughs, is then slipped through the roller and fixed with cones for U bore; the mandrel with the roller is then placed in the frame of the varnishing machine. When collars are used for larger bores these must be adjusted to enable the roller to run true. If the roller should be a little tarnished, wiping it with a wet cloth dipped in powdered bathbrick will thoroughly cleanse the surface. A cloth saturated with turpentine will suffice, if it is not tarnished. Should the roller be chilled a slight blow of steam through the perforated pipe will improve the surface for receiving the varnish. Some pentagraph varnish (which should be kept slightly warm) is poured into a small tin, the quantity being judged according to the size of the roller, and poured across the roller while in motion. The dauber is now placed on the roller and worked backward and forward for some time. The roller will now have a dark brown appearance.

If a wide bore handkerchief roller is on the machine a circular piece of wood with a slot of the same size as the tube is placed against each end of the roller to prevent the escape of steam and water. The steam is now turned on, the heat gradually melting and converting the varnish into a beautiful glossy and light amber-coloured coating. When this colour appears towards the ends, steam is shut off and the water turned on to cool the roller previous to removing it from the machine.

Defects in Varnishing.—If satisfactory results are to be obtained with the engraving, rollers must be evenly coated with varnish, neither too heavy nor too light. The length and circumference of the roller has to be taken into consideration, and, therefore, more or less varnish placed in the small vessel used for pouring it on. If spiral marks show on the surface, the roller has been overheated previous to distributing the varnish. If grit and sediment appear, the dauber may require cleaning, or the varnish should be again strained. Bubble marks on the surface of the roller near the ends is a sure sign that drops of water have been allowed to come into contact with the roller in the process of cooling. These are points which can be easily avoided, but are most important if uniformity of varnishing is to be obtained.

Filling-in Rollers.—Various classes of work require to go through this operation for shade lines giving a grey effect, and fine shades for a superpose effect, and all solids of a more or less large description. In these cases the outlines and all detail work are previously engraved and the rollers nicely polished to take away any "burr" from the surface. They are set into the varnishing machine in the manner

already explained, and the steam turned on to heat the roller. Ball or fill-in varnish (used in sticks) is rubbed across the surface, and while the roller is in motion a small steel doctor or scraper (see fig. 270) is held flat against the surface of the roller slightly on the angle and passed over it. This has the desired effect of filling the engraving with the ball varnish and scraping the surface clean. Any excess will come away on the doctor. The roller is now well cooled by turning on the water. Ruling varnish is spread over the roller and the dauber used to spread it in the manner described for varnish pentagraph rollers. Heat is now applied to assimilate this surface varnish, but great care must be taken that the roller is not overheated, otherwise the ball varnish will "spring" out of the engraved lines, leaving a clear edge which renders it useless for its purpose; in such cases it requires to be washed off and the lines to be refilled. While the roller is still hot it is transferred to the ruling machine.

Ruling Machine (see fig. 262).—This machine is of simple construction, and can be geared up with different wheels, as used for the mill machine, to obtain different speeds for various sizes of rollers. It is found more convenient, however, to have a three-speed grooved pulley at the driving end, the small rope drive being on the smallest pulley for the garment rollers requiring the quickest drive; on the mid pulley, for rollers up to about 24 inches in circumference; and on the largest pulley, for rollers above this size, so as to reduce the speed and have the surface travelling at a speed about equal to that of the smaller sizes. The mill frame A is fixed to the sole plate B, which moves on the shears C, and is geared into the screw mandrel D running the length of the machine. The mandrel E is placed through the roller F about to be ruled and adjusted on cones so as to run true. The mill frame is then moved to the end of the roller.

Setting the Ruling Mill (see fig. 263).—This adjustment requires skill to work in a perfect manner, otherwise the mill will not traverse perfectly. The set screws on each side of the crescent shape G in which the ruling mill is set on the centres of the pivots are adjusted in a careful manner to avoid side play, and yet not so tightly as to prevent smooth running. The telescope pillar H in the mill frame is raised or lowered to suit the circumference of the roller, and can also be twisted to the right or left in order to alter a little (if desired) the slash of the ruled line. The head of the mill frame is now gently lowered down until the ruling mill rests on the roller. The mill must be slightly "canted" by screwing the pins I right or left as required, and the surface of the roller marked, as shown in fig. 264. This is done for the purpose of giving a leading and cutting edge through

the surface of the varnish. The roller is now gently turned round to see that the mill joins itself or traverses in the circumference. If out of traverse a slight alteration of the top screw I will usually have the desired effect. The driving band is now connected and the machine set in motion. A small lead weight can be suspended

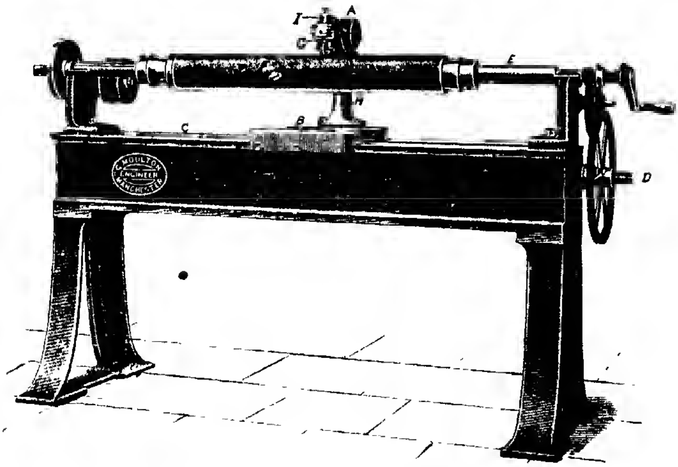


Fig 262 —(Mill) Ruling Machine.

from the top, if extra pressure for cutting is required, which is often the case with ruling mills after they have become slightly worn; but it is not advisable to work with well worn mills, as too great a

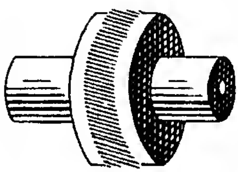
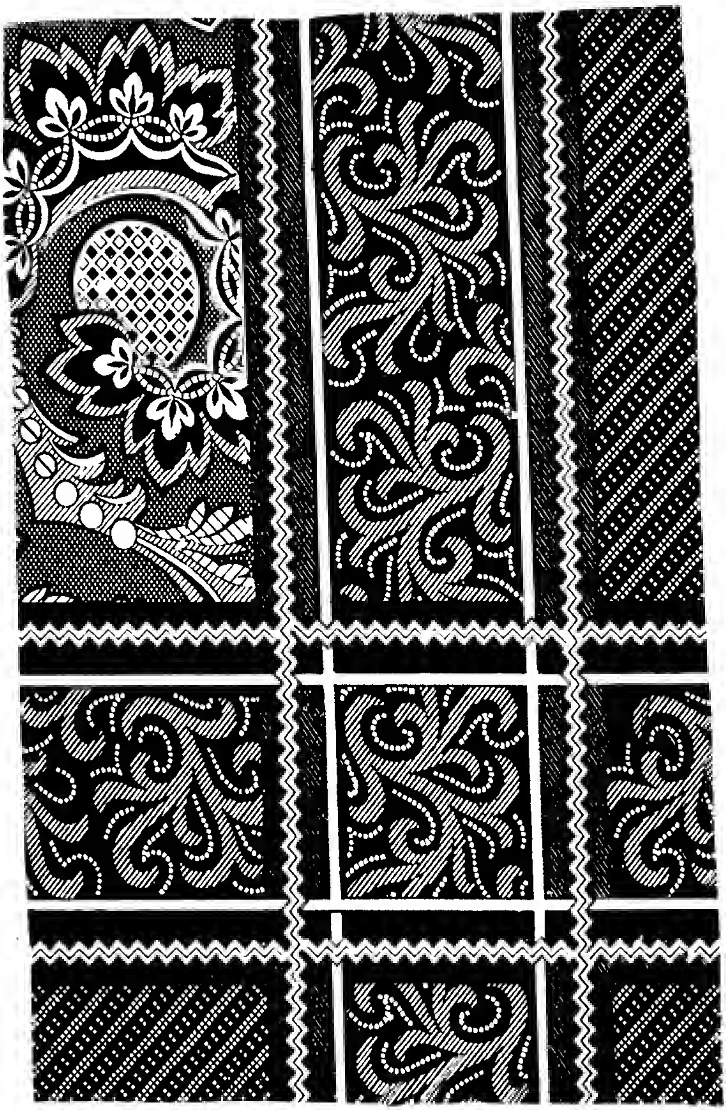


Fig. 263.—Ruling Mill.

Fig 264 —Showing how Ruling Mill marks on Roller when slightly "canted."

weight is required to give the necessary cut through the varnish, which would then show too heavy lines in portions of the surface of the roller, and necessitate extra polishing to clean these marks away, sometimes to the detriment of the surrounding engraving. When this ruling is completed the roller is ready for painting.



265.—Pattern which requires Three Rulings

Several Rulings.—It frequently occurs with handkerchief engraving that rollers require to be ruled three times (as shown in fig. 265), twice for shades and once for solids. It is imperative in cases like this that one angle of the shades be ruled first, then the roller painted and etched. The same operation is gone through for the reverse shade, and again for the solids. When filling in the roller for the solids it is advisable to dispense with the small steel doctor for cleaning the surface and use instead a piece of hard wood to avoid any risk of tearing the shade lines, which is apt to be done when using the steel against these angled shades. Especially is this so when a roller, after having been once ruled for fine solids, is being prepared for a second ruling of a coarser description.

"**Run Outs.**"—This is a term used when the ruling mill gets out of traverse and leaves a doubling of the line. This defect may occur at any part across the roller, and is usually seen all round the circumference. If the ruling is for a blotch, or large pieces of peg work, it is always advisable to remove the roller from the machine, wash off the varnish, and give the roller a light polish with the "Water o' Ayr" stone to break the "burr" occasioned by the ruling mill. Care must be taken that the polishing is not overdone, otherwise the finer parts of the engraving are apt to get weakened. The roller is again prepared for ruling.

A "run out" may occur from several causes. By the mill dipping into a solid part previously engraved; crossing a broad mill line, especially on handkerchief work; or the pivots in which the mill is set having become "shouldered."

"**Stagger.**"—This term is used when the mill has "jumped" and shows a doubling of the line for about half the width of the mill all round the roller, and then again follows the traverse. This defect may be burnished out with the finger by drawing it across in one direction, thus closing up the lines. The mill is again set into the line and the traverse again followed. If only small portions are to be left when painted the false line can be touched with paint.

The "stagger" is usually caused by a small lump of hard varnish being left on the surface of the roller. It is most important that the surface of the ruling mill should be thoroughly brushed out with a piece of wire card previous to placing it in the mill frame, as small pieces of varnish sometimes get caked into the lines. Should the lines of a mill incline to get clogged with running, a simple preventive may be used, by having a small piece of white cloth touching the surface on which water is poured occasionally as the mill runs across the roller.

Ruling mills, when being stored, should be placed in order, and well covered with oil or tallow to prevent any corrosion taking place.

Perfection in Etching.—To secure perfection in etching with a design, such as shown in fig. 265, where three separate rulings take place—first, for the shade lines on one angle, then the roller painted and etched and lightly polished with a saddle stone; second, refilled with ball varnish and ruled for reverse angle of shades, again painted, etched, and polished; third, refilled, ruled for solids, painted, and etched. These operations require the greatest care, not only to avoid mishaps, but also to ensure the work being produced of the most perfect and level character.

Fig. 266.—Painter Girls at Work.

This type of pattern might be classified as the most difficult in the art of etching, as the slightest shadow of unevenness will condemn the work when printing takes place.

Painting (see fig. 266).—The roller, when ready for painting, is covered all over with a shade line cut through the surface varnish (see fig. 267, A). The object in painting is to cover every part of the roller with a resist varnish called "paint," except the parts to be left representing shades or solids forming the pattern. The pitch of the roller, 1st, 2nd, or 3rd, is noted, and the colour on the design representing this pitch followed out as outlined on the roller. The

girls first use a fine sable-hair brush, painting a thick line (as shown in fig. 267, B), and go all over the roller in like manner, then they further fill in the parts requiring protection (as shown in fig. 267, C) with a medium or coarse brush, as convenient. When working with a fine brush it is of the greatest importance that the outline on the roller be accurately adhered to; if carelessly painted by going over

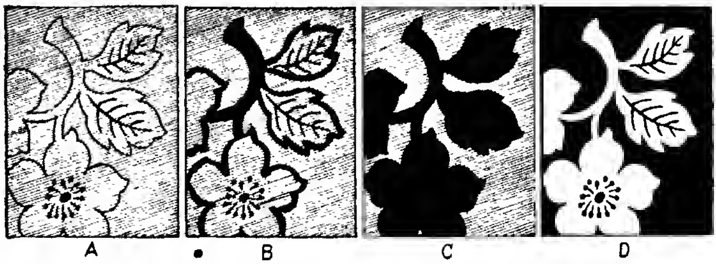


Fig 267 — A, As engraved on roller and ruled ready for painting; B, showing outline painted; C, painting completed ready for etching; D, etching completed and roller cleaned

the line, it entails an immense amount of labour for the hand engraver in "picking" away the small whites represented in fig. 165. If painted short of the line the defective parts would require to be "plugged" or "mended." A clean painted roller not only saves unnecessary time being expended in finishing by the hand engraver, but gives a sweetness of finish which commands admiration.

To secure clean painting it is of the utmost importance that several points should be attended to. The paint, before using, should be well stirred in a small pot (as shown in fig. 268), and also be of the right consistency. If thick, a few drops of turpentine should be added, and the paint again well stirred. The brush should be occasionally cleansed by washing it in turpentine to prevent any clogging taking place. The paint, if stirred frequently, will add to the smooth working. If a small part should happen to get painted in the wrong place it can be remedied by tracing the ruled line lightly through with a needle point after the paint has set a little.

Fig. 268 —Painter's Pot.

When the roller is finished it should stand, at least, one hour to allow the paint to dry previous to etching. A roller placed in the acid while wet will lead to disastrous results, as it will be perforated with acid holes.

Repairs Covering.—This term is applied to the process of coating the surface of an engraved roller for the purpose of deepening all or certain parts of the work: and may be applied to new as well as old engravings worn down after printing. The roller first receives a polish, and if a blotch exists a saddle stone must be used, but for ordinary peg work a flat stone will suffice. The roller is next set into the varnishing machine and receives a rub over with turpentine, also a slight heating. A little of the special varnish used for this purpose is poured over the spreader roller while in motion, and the dauber well worked backward and forward on this, until a nice level coating appears. The dauber is then "laid on" the roller to be covered, but must not be worked too and fro. The varnish should only cover the surface and not sink into any parts of the engraving. A second coating, or even a third, may be necessary until the surface of the roller shows a coating that will resist moderately strong acid. The roller is now examined and any defects on the surface touched with paint. Parts of the engraving considered strong enough can also be covered with paint. After this it is ready for the etching troughs.

Etching Repairs.—Judgment should be exercised here to secure the best results. It is much better that a "fent" be supplied by the printer which will at once show the defective parts. Usually it will be found that the engraving is weakest towards the ends of the roller, and sometimes one end is weaker than the other. The roller is placed in moderately strong nitric acid for a few turns, which will at once show if the acid is "biting" equally all over. When lifted out several parts of the varnish should be rubbed off, and examined with a lens to see that the surface is clean—*i.e.*, has withstood the acid. A brushing out with water towards the ends will assist the weaker parts to etch better. The roller is again placed in the acid, and if the ends are still showing weak, it is better to raise the roller on blocks clear of the acid, and then with a jug gently pour the acid over the end, gradually working it in towards the centre. The same operation is repeated from the other end. The engraving is now examined at several places across the roller by rubbing the varnish off the surface. The "jugging" operation can be repeated if necessary, and judgment used by painting out certain parts at each repeat that may be considered strong enough, and further etching continued for the remainder of the work. Two or three hours spent in stopping out, will, on many occasions, make a satisfactory repair which otherwise would be a failure.

Para-deep Covering.—If the engraving should be very much worn it is better to cover with letterpress printer's ink (black), and etch

with the iron perchloride solution. This method was introduced by Mr. Ker of the Process Engraving Co., Glasgow, who also named it "The Para-deep process." It takes longer to accomplish this than if done by the other method, but for well-worn engraving, and where great depth is required without swelling the work too much, it is an ideal method of getting a satisfactory result. The polishing, by way of preparation, is gone through in a similar manner, and the roller set in the varnishing machine. A small dauber roller, about 12 inches long and leather covered, as used by process engravers, is employed for the purpose. On a large square of strong zinc a very little of the ink is laid on and well worked with the small roller until thoroughly spread. The small roller is then placed level on the cylinder to be covered. A slight angle will cause it to run in spiral fashion across the cylinder. A second coating may be given, and the cylinder dusted with powdered resin. This will adhere to the surface without going into the engraving. It is then dusted with French chalk, some more ink spread on the zinc plate and the small roller worked up, and transferred, as formerly, to the cylinder, and again dusted with the resin and French chalk. If the surface is not well covered, a third coating may be necessary; finally, it is brushed out with a soft brush and water. The cylinder then requires to be equally heated up with gas; usually a perforated rod is placed inside the cylinder which is gently turned round. The surface will gradually show a beautiful glossy coat, and the finest parts of the engraving will be perfectly clear. When the cylinder is cool it is examined for scratches or defects previous to etching, which must be done in the iron perchloride solution, after the same manner as explained for nitric acid. Cylinders covered in this manner will stand very weak nitric acid, but the surface will break away if the strength is moderate. It is, therefore, better to etch completely in the perchloride solution.

This method is an adaptation of the process used by copper plate engravers.

CHAPTER XXI.

VARNISHES USED FOR VARIOUS METHODS OF ENGRAVING.

There are five different kinds of varnishes used in calico engraving, viz.—Pentagraph, ruling, ball, paint, and covering. Each has a separate recipe, but they are all composed of one or more of the following ingredients:—Bees-wax, asphaltum, Burgundy pitch, black pitch, gum-mastic, and resin.

After boiling they are thinned down with turpentine to the desired working consistency, except the ball varnish.

Bees-wax is a name given to certain substances of different origin. We have the animal or pure bees-wax, vegetable or palm wax, and mineral or ozokerite wax. Bees-wax is the best for engraving purposes. Pure bees-wax is of a dull yellowish colour in its natural state as collected from the boiled honeycomb. There are various kinds placed upon the market, Chilian, Russian, Italian, and British. The Chilian is very pale in colour; Russian, medium; and Italian and British, dark in colour. The Italian can be purchased at about half the price of the British, and is equally good for varnish purposes. Bees-wax resists nitric acid, but takes on a bleached appearance when left in the acid for any length of time.

Asphaltum or mineral pitch, also sometimes termed bituminous limestone, was used by the ancient Egyptians to enbalm their dead, and by the Babylonians as mortar. When this material is treated with ether it is rendered sensitive to light, and is frequently used in photo etching. It is now found in dried-up beds of petroleum, as in the region of the Dead Sea and in Trinidad. It has a dark brown dusty appearance.

Black Pitch, also a mineral, and of a dark chocolate colour, is brittle, and has a vitreous, glassy, or quartz-like appearance with a good resinous quality. It is obtained from coal tar.

Gum-mastic is of vegetable origin, being the resin exuded from the mastic tree. It is procured in small bean-shaped pieces, and is pale yellow in colour.

Burgundy Pitch is also of vegetable origin, being the resin of the

spruce tree. It is of a yellow candy nature, and is a solid cake at the ordinary temperature of the workshop. Owing to this substance being so liable to boil over, it is better to be the last added in mixing, and should be placed in by degrees when making varnish.

Resin is a solid inflammable vegetable substance obtained as gum from trees either by exudation or extraction. There is also a kind of mineral resin obtained from coal tar. The vegetable product is the best for making varnish.

All these products resist nitric acid, and all, except the bees-wax, can be dissolved in turpentine.

Recipes.—Regarding the recipes for making the various varnishes, engravers naturally differ to some extent, and this may partly be accounted for by the fact that they are used in various workshops under different conditions, the variation of some of the quantities suiting some places better than others. One important point that should always be attended to is the making of the pentagraph varnish a little softer in winter than in summer. This tends to prevent "chipping" during spells of frost, and can be easily obtained by adding 2 or 3 ozs. more bees-wax, with a quarter of an hour's less boiling. Excessive boiling tends to harden the varnish.

When boiling the ingredients, it is better to use a copper pan placed on a gas ring, which enables the heat to be regulated as desired. It is also advisable to make the varnish beneath some kind of funnel which will carry away the fumes. The bees-wax should always be used first, and partly melted before any of the other ingredients are placed in the pan. Stirring should be done often, and constantly for some time before the varnish is taken off. When the turpentine is being added, it is advisable to remove the pan from the gas ring and pour it in gradually while stirring quickly, otherwise it is apt to catch alight, and to cause disastrous results. Should this unfortunately happen, it must be smothered in sand, as the addition of water is of no use.

Pentagraph Varnish—

10	ozs.	Bees-wax.	6	ozs.	Black pitch.
9½	,,	Asphaltum.	4	,,	Gum-mastic.
8	,,	Burgundy pitch.			

Boil slowly for 2½ hours from the time the asphaltum is added. Stir in the gum-mastic half an hour before taking off. Add 3 quarts of American turpentine.

Blotch or Ruling Varnish—

8 ozs.	Bees-wax.	4 ozs.	Black pitch.
8 ,,	Asphaltum.	2 ,,	Gum-mastic.
4 ,,	Burgundy pitch.		

Boil, and add turpentine as for pentagraph varnish.

Ball or Fill-in Varnish—

10 ozs.	Bees-wax.	2 ozs.	Black pitch.
12 ,,	Asphaltum.	2 ,,	Gum-mastic.
2 ,,	Burgundy pitch.	2 ,,	Resin.

Boil about $2\frac{1}{2}$ hours, and pour into paper tubes. The surface of the paper should be waxed before being rolled on a circular piece of wood to form the tube.

Paint (Varnish)—

$\frac{1}{2}$ lb.	Bees-wax.	$1\frac{1}{2}$ lbs.	Resin.
2 lbs.	Asphaltum.		

Boil slowly for about two hours, and add about 2 pints of turpentine.

Covering Varnish—

13 ozs.	Bees-wax.	12 ozs.	Burgundy pitch.
12 ,,	Asphaltum.	$1\frac{1}{2}$,,	Gum-mastic.

Boil slowly for about two hours, and add gum-mastic half an hour before taking the varnish off the flame.

The pentagraph, blotch, and covering varnishes should be strained while warm, and kept in a well-corked tin or jar.

CHAPTER XXII.

IMPRESSIONING THE FINISHED WORK.

Cloth to be used.—Great taste can be displayed in connection with this operation for showing off the finished engraving to the best advantage.

For impressions, or "rubs" as they are sometimes termed, a fine cotton cloth is used for all print-on patterns whether they be white grounds or blotches.

For discharge patterns the cloth can be dyed the required ground colour, or coloured paper used, but cloth is preferable to paper.

When the cloth is bleached and well stentered it is better to give it a little assistance, as it is termed—*i.e.*, a run through starch before being calendered. This helps to fill the cloth, and tends to show the colours to better advantage.

Cutting and Damping the Cloth.—It is cut into sections to suit the various classes of work. For ordinary garments, one pattern on the roller, 10 by 6 inches will suffice, but for two patterns on a roller, 15 by 6 inches is required. For handkerchief rollers with one pattern on, 11 by 7 inches will do; and for two patterns, 16 by 7 inches is advisable. When cutting the cloth, it is a convenience to so place it that the warp will lie across the roller. If the rubs are to be done by hand, this prevents the cross rubbing from stretching the cloth, and ensures better fitting when the various colours are placed together. If the machine is used, the warp should lie in its natural state—*i.e.*, along the circumference. The cloth is always used in a slightly damp condition, which allows the finer parts of the engraving to be transferred to better advantage.

A section of the cloth is well soaked with water, and laid between every six pieces of the dry cloth. The lot is then placed in a press, and is found to be in fine condition the following day, owing to the dampness having penetrated through all the cloth.

Impressioning by Hand.—Previous to the introduction of the machine all the impressioning was accomplished by the hand. Since

then, with handkerchief rollers of large size, it is usually done by the hand method in the following manner :—

The roller is placed on a low bench in V-shaped wood blocks to prevent it from turning round. The colour is then laid on a small rubber brush, as shown in fig. 269, and well rubbed into the engraving at the required parts. The small doctor (see fig. 270) is drawn around the surface of the roller, and must leave this thoroughly clean, the engraving only being filled with colour. The piece of cloth is then laid on and the small roller or squeegee (see fig. 271) moved equally

Fig. 269.—Rubber Brush.

Fig. 270.—Small "Doctor."

and smartly backward and forward across the roller; if a slight angle be imparted to the roller it gradually passes over the whole surface. The cloth is then lifted from the surface and compared with the design to see that the shade of the colour is right, and also the balance of work in accordance with the design. If the colour is too soft it can be stiffened up, or if too dry it can be softened down a little. These two points, the shade and the consistency of the colour, ought to be attended to with the first impression from each roller.

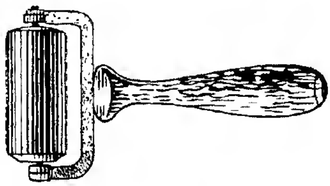


Fig. 271.—Roller or Squeegee.

The operation of rubbing in the colour and cleaning the surface of the roller is again repeated until the required number of rubs are obtained. The first roller is usually the one with the finest engraving on it, especially where the fall-on effects are to be placed on the top, because if the paler colour goes on first the finer parts will not show to the same advantage. At the same time, good taste and judgment require to be exercised, as several or all rollers of the same pattern may have fine engraving to contend with. It is then a question of which colour ought to get preference.

The two pitches as marked on the first roller, which show on the impressions, will require to be laid down on the second and succeeding rollers to the two corresponding pitches, and treated with their respective colours in the same manner as the first, until the pattern

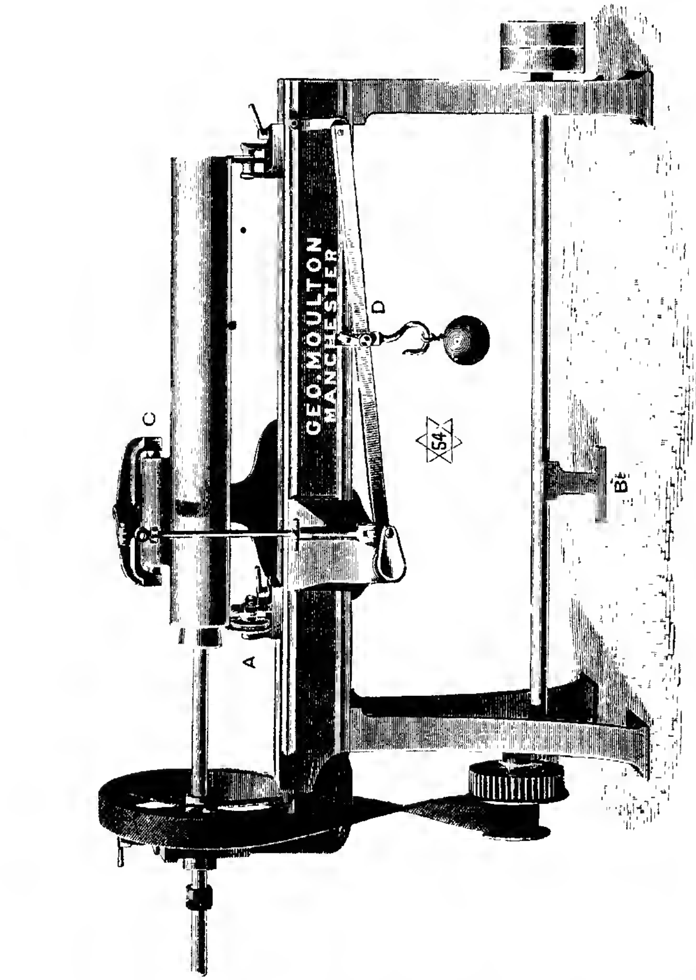


Fig 272.—Impression Machine

is complete, and show what is termed a fitted impression. "Singles" are impressions in their respective colours without being fitted to the various rollers.

Impressioning by the Machine (see fig. 272).—The roller is placed on the steps marked A, and the colour spread over the part to be impressioned in the same manner as explained for the hand method. The small doctor is held on the surface of the roller and the foot placed on the treadle B. The roller will then slowly revolve, thus cleaning the surface. The piece of cloth is laid on the surface of the roller and the bowl frame C brought over and rested on the roller. The weight on lever D is adjusted to give the necessary pressure, and the foot set on the treadle, thus turning the roller round. On lifting the foot the machine will stop. The lever weight is drawn in, and the bowl frame thrown back. The impression is then pulled from the surface of the roller. On examining the first impression it will be observed whether more or less pressure is required, and the stop screw on the lever adjusted accordingly. The fitting of the impression by the pitches for the succeeding colours is done in the same manner as in the hand method.

This method of impressioning by the machine is very little quicker than by the hand, but it has the great advantage of showing the impressions more equal, and, specially for fine work, it shows the engraving much sharper.

A recent introduction, which has proved to be of great service, is the covering of the bowl with laundry rubber instead of with printers' blanket, which was found to be too spongy and required frequent renewal owing to the colour getting smeared on it. The rubber is found to be firmer, and yet gives sufficient yield. There is no trouble in stitching at the joining as in the case of the blanket, and, further, the bowl can be washed when required.

Mangling and Trimming the Impressions.—These operations are done with a view to showing the rubs taken off to the best advantage, a small two-bowl mangle about 16 or 18 inches wide being sufficient. It is also advisable to have the bowls skeleton, which allows a small perforated rod with gas connection being placed inside to heat the cylinders, thereby imparting a better glaze on the surface of the rubs. They are then trimmed by cutting them all to the same size. A little time spent on these two seemingly trivial operations will show the design to much better advantage when placed in the merchants' hands.

Mixing Colours for Impressioning—*Print-on Work*.—These require to be of a stiff consistency to prevent undue flushing. They must appear clean and bright on the face of the rub, as there are no after operations, as in ordinary printing, such as dyeing, steaming, or soaping. The colours are, therefore, composed principally of starch

paste with the addition of aniline colour in a fluid, yet concentrated form.

Flour Paste.—A small quantity of flour paste should always be kept in readiness, because strong engraving is better impressioned with half starch and half flour in making up the colours.

Flour paste is made up as follows:—1 lb. flour, 3 pints water, 3 ozs. olive oil, 1 oz. resin. Steam boil till thick.

A small quantity of paste is laid on the palette and a little of the aniline colour placed in the centre and well mixed with the palette knife. If desired stronger, more colour is added; if required weaker, more paste, or a little flake white, would be added. It is always advisable to try the colour on a small impression from the roller, which can be darkened or lightened as required, or, if rather thin, a very small quantity of dry flour or powdered gum arabic mixed with the colour will stiffen it up as required.

Chintz Patterns.—For impressioning, say, a five-colour chintz pattern, 1, red; 2, pink; 3, dark olive; 4, light olive; 5, blotch; it will be found on a study of the design that the red is the leading colour, and should, therefore, be impressioned first, more especially if there are red shades falling on the pink to produce a superpose effect.

By taking off the red first it gives the shade a better chance of showing up well. The pink is taken off next, and should the colour incline to dull the red shade, by laying the impression (face down) on a piece of white paper, and giving a gentle rub over the back, a little of the surplus colour will be taken off, and clear the shade, without in any way injuring the tone of the pink. The dark and light olive are followed up in the same manner before placing in the blotch, which should always be done last.

It is a common practice, and assists the salesman's purpose, to show an impression or two without the blotch; also, if two or three colours of the same pattern will indicate an intelligent combination as a design, it is advisable to also show them, as it always tends to secure more printing orders from the same design.

These points should be studied by the impressioner as well as by the designer.

Colours for Impressioning—*Discharge Patterns.*—For impressioning this class of work on coloured paper or cloth, the colours must also be of a stiff consistency, but as each of the colours must be opaque, so as to kill the ground colour as far as possible, the making up of the colour is done in the following simple manner:—Oxide of zinc

is mixed with starch paste, and the desired colour (aniline) then inserted, and well mixed together on the palette.

Purpose of Colour.—In calico printing, colours are used with the definite object of brightening and beautifying the fabric, the cloth serving in many cases simply as the structural medium on which the decoration has to be placed. Colour, in these instances, is of more consequence than form, as it may redeem an otherwise uninteresting design, whereas a displeasing colour combination may render worthless the best design. An indifferent impression may, therefore, condemn excellent engraving, whereas a good, clean, well-fitted impression, with colours well harmonised, will commend indifferent engraving. An ideal impression is often the fore-runner of large orders for printing.

Theory of Colour.—Sir Isaac Newton demonstrated in a simple manner with the aid of a glass prism that light is the source of all colour, and the band of coloured light thus obtained is called the solar or prismatic spectrum, and the colours classified as follows:—Red, orange, yellow, green, blue, and violet.

According to Sir David Brewster's theory there are only three colours, red, yellow, and blue; while according to Helmholtz (a noted physicist) the three primary constituents of white light are red, green, and violet While all agree that if white light falls upon a piece of white bleached cloth all three constituents of the white are reflected from the cloth into our eyes, and the cloth appears white. The colour of a body is, therefore, determined by the character and intensity of the light rays that it reflects. All bodies have the power to break up the light that falls upon them, and to absorb or reflect the different waves or colour rays of which the light is composed.

Suppose we mix blue with yellow, the mixture will appear green, but not because, as so many people suppose, blue and yellow make green, but because green is the only constituent of white light reflected by both these pigments.

A piece of red cloth will appear red to us, because the rays of white light which falls upon the white cloth have lost two of the three constituents of light—viz., the green and the violet—and only the red is reflected into our eyes, and acting upon a certain portion of the retina produces the sensation, which we call redness.

Mixture of Coloured Pigments.—The effects produced by mixing coloured pigments, as explained by the Brewster theory and adopted in the practical application of colours in dyeing, are as follows:—Red, yellow, and blue are taken as simple or primary colours, because they cannot be obtained by mixing other pigment colours, whereas,

by their admixture in different proportions and with the addition of black and white pigments, practically all other colours can be produced.

When two of the simple colours, or the three, are mixed the resultant colour is termed a compound colour. By mixing the primary colours in pairs, secondary colours are formed, while the mixing of the secondary also in pairs produces tertiary colours as follows :—

Primary.	Secondary.	Tertiary.
Red	Green (yellow and blue)	Russet (purple and orange)
Yellow	Purple (red and blue)	Citron (green and orange).
Blue	Orange (red and yellow)	Olive (green and purple)

In connection with primaries, red may be said to hold an intermediate position, yellow advances, and blue retires.

In forming secondary colours yellow and blue produce green, red and blue produce purple, and red and yellow produce orange, while the tertiary colours are produced by mixing purple and orange for russet, green and orange for citron, and green and purple for olive ; but in each case one of the three is in excess of the other colours.

Qualities of the Primary Colours.—Different effects are produced on the mind by different colours ; red, for instance, is a brilliant and cheerful colour, and gives the feeling of warmth, and is said to equal the maximum "heat ray." Yellow is a very luminous colour, and equals the maximum "light ray," and blue is a cold colour, and equals the maximum "chemical ray."

Qualities of the Secondary Colours.—They are somewhat intermediate between the primaries of which they are composed. Green has the feeling of coldness, but appears fresh. Purple is a rich and deep colour, and for bloom and softness is unsurpassed. Orange is a strong colour, and possesses a feeling of warmth.

Harmony in Colour Combinations.—This is a subject which requires great study, and as there are no fixed principles to govern harmony of colour it must be left to the observer to decide what constitutes harmony, as colour sense is more highly developed in some persons than in others.

Dark grounds are more suitable for the application of bright colours, such as red, orange, and yellow, than light colours, as their

qualities of brightness are intensified on the former and diminished on the latter. On the other hand, sombre colours, such as violet and purple, are deepened and enriched on light grounds and lowered on dark grounds.

These examples are sufficient to enable one to comprehend the great advantage to an impressionist who understands the elementary principles of colour harmony.

CHAPTER XXIII.

TURNING OFF COPPER ROLLERS OR CYLINDERS.

Primitive Method of making Cylinders.—With the introduction of the cylinder printing machine in 1783, the engraving had to be executed on rollers. These were first made in a rather primitive manner; the heavy sheets of copper were rolled to a circle and soldered with spelter at the joining. Shortly thereafter the more modern method of moulding the cylinder was brought into requisition.

Bore of Cylinder.—Every cylinder must have a taper on the bore whether it be for a garment or a handkerchief, solid copper or electro. It is required for the purpose of "jamming" the roller on the mandrel or "slip" of the printing machine. This taper on the bore is reckoned on a length of 36 inches—viz., $3\frac{1}{2}$ inches diameter at narrow end and $3\frac{5}{8}$ inches diameter at wide end, which makes a taper of $\frac{1}{8}$ inch on 36 inches, as shown in fig. 273, and known as U.B. (Universal Bore),

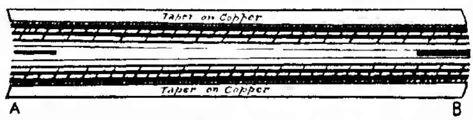


Fig. 273.—Cross-section of Roller showing Taper of Bore.—A, wide end of roller; B, narrow end.

for garment rollers whether solid copper or electro. It, therefore, follows that rollers longer than 36 inches will get narrower in the bore at the narrow end, and wider in the bore at the wide end. For instance, a roller 72 inches long would measure $3\frac{7}{16}$ inches in diameter at the narrow end and $3\frac{11}{16}$ inches in diameter at the wide end.

Feather in Cylinders.—Every cylinder inside the bore has a projection running the whole length for solid copper, and about 6 inches at each end for electro rollers, called a "feather." This feather fits into a groove on the printing mandrel or "slip" to prevent the roller from turning round.

The outside circumference of the cylinder being equal, it follows there must be a thick end and a thin end on the roller. The thick

end of the metal is known as the narrow end, and the thin end of the metal as the wide end of the roller. When rollers are standing on end, or lying on the angle against a rack, the wide end shou'd always be uppermost. This is for two reasons—1st, they stand steadier owing to the heaviest end being towards the floor; 2nd, all pattern and roller numbers being stamped on the wide end, they can, therefore, be identified with convenience.

Stamping the Rollers.—The unwritten rule to follow in this case is for all pattern numbers to be stamped on the face of the roller, and the roller numbers on the end, all at the wide end, as shown in fig. 274. If the roller numbers are also stamped on the face of the roller they become obliterated when turning off takes place, but when stamped on the end they remain; therefore, there is less liability of error when restamping figures.

Weights of Solid Rollers.—A solid copper roller, 36 inches long by 15 inches in circumference will weigh about 92 lbs., or about $2\frac{1}{2}$ lbs per inch of length. A 56 inches long by 16 inches in circumference solid roller will weigh about 186 lbs., or an average of about 3 lbs. 5 ozs. per inch. Handkerchief rollers vary so much in bore and thickness that it is unnecessary to give details of weights. Thickness of copper is always taken from the end having the largest diameter of bore: thus a roller having a bore of $5\frac{1}{2}$ inches in diameter by $5\frac{5}{8}$ inches would be recorded as $5\frac{5}{8}$ inches diameter bore. The price of copper fluctuates according to the market, but there is a fixed standard of extras for handkerchief rollers as the bore increases beyond the universal size.

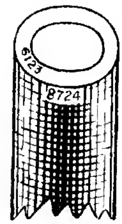


Fig 274 Showing how Rollers are Numbered

Turning off Solid Rollers.—By this is meant the cleaning off of the old engraving by the turning lathe to give a fresh surface on the roller for the new engraving. The loss of copper depends very much on the depth of the old engraving. Usually a garment roller, 36 inches long and 15 inches in circumference, loses 3 lbs. in weight, and a 50-inch roller, about 4 lbs. They are also reduced about $\frac{1}{8}$ inch in the circumference with each turning. Handkerchief rollers lose more as the circumference becomes larger and the roller longer, usually from 6 to 10 lbs. They are reduced about $\frac{3}{16}$ inch in the circumference. It will be observed that the turning lathe (see fig. 275) shows a four-speed pulley. By making use of these to suit the various sized rollers it is found to be much quicker than altering the gearing to obtain the same result. For garment rollers the quickest speed

can be used by placing the driving belt on the smallest pulley of the lathe, and on the largest pulley of the counter shaft. For rollers of medium circumference the centre pulleys are used on both the lathe and the counter. And for rollers of a large circumference the driving belt is placed on the large pulley of the lathe and the small pulley of the counter.

If more than one roller is required to make up a pattern, the turner would measure with a copper tape the various rollers, and turn off first, the smallest in circumference, or if all were equal, he would start with the roller having the strongest engraving, usually a blotch, and endeavour to reduce this roller as little as possible, thus saving an immense loss of copper by excessive turning off on the other rollers composing the set.

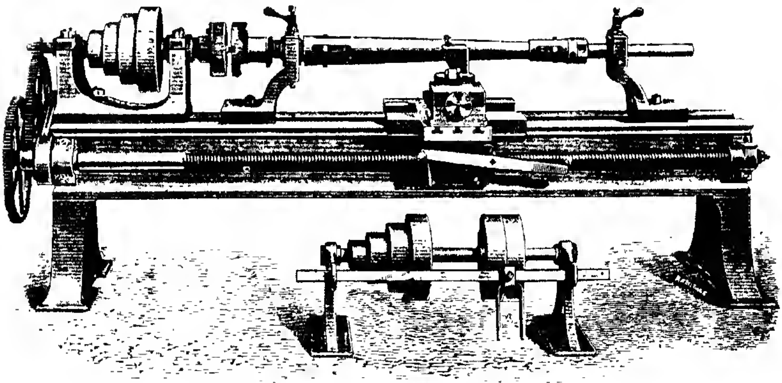


Fig 275 —Copper Roller Turning Lathe

When the roller is slipped on to the mandrel, it is set true by setting the lathe in motion and touching the point of the tool on the surface of the roller to see that it has marked equally all round.

The lathe is again started and the point of the tool adjusted into the copper. When the carriage has moved 2 or 3 inches along, the lathe is stopped and the copper tape pulled tightly around the part turned off, and marked with a knife by drawing a line across the double surface of the tape. The lathe is again started, and the tape tried several times across the length of the roller as the carriage moves along. This is imperative, as some lathes incline to run " out " or " in " as the carriage moves across the bed. This precaution ensures the rollers being turned true. The same gauge is then used in the same manner for the other rollers of the set.

Turning Tools.—These must be of the best steel, triangular in shape to suit the holder, and about 6 inches long. They are ground away at one end to about 45 degrees, and slightly rounded on the point. If too sharp they leave a heavy "cording" on the surface of the roller when turned, which occasions extra polishing.

Sizing the Roller.—This is necessary both in turning and polishing to maintain not only a "straight" roller, but also to ensure all rollers of the same pattern being similar in circumference so as to give correct fit or register when printing.

Burnishing Rollers.—When a roller is used to complete a set, and found to be several lines small, say, up to $\frac{1}{16}$ inch in circumference, instead of turning down all the other rollers of the set (which would entail a great loss of copper), burnishing out the old engraving on the mill machine is resorted to. This maintains it the same circumference as the other rollers of the set when turned. This method can only be adopted when the engraving on the roller to be burnished is not deep and of a floral nature. With cross lines or heavy solids it is impossible.

Burnishing with a view to reducing the strength of the new engraving is also adopted. When a roller has inadvertently been over-etched, burnishing has the effect of closing up and sharpening the engraving. It is accomplished in the mill engraving machine with a smooth-surfaced mill, gearing being set up to give a spiral or continuous run from one end of the roller to the other.

CHAPTER XXIV.

POLISHING ROLLERS.

Garments.—After the rollers have been turned off they require to be polished on a lathe (see fig. 276) previous to engraving. This is termed plain polishing. The spindle of the lathe is lifted from the bush, swung out, and laid on the rest outside of the bush at the driving end, and thus placed on an angle clear of the trough. The roller (wide end first) is now lifted and slipped along the mandrel, placing the feather of the roller into the groove of the cone. A cone is then slipped over the mandrel and fixed in like manner at the narrow end, followed by a rubber ring, and, finally, the nut screwed against the rubber ring. The mandrel is raised from the rest and placed back in the bush. The roller is now tried to see if it is running true by setting the lathe in motion and touching the point of the thumb in any black or dirty oil and steadying the hand on the trough, allowing the thumb to touch the surface of the roller. This is done at each end and the machine stopped. It will be at once seen if it has marked all round the roller; if so, the roller is running true. If marking at one part only the cone should be struck lightly at the opposite side from the mark, which has usually the desired effect. When the bore of the cone begins to get worn it is sometimes necessary to place a round of very thin brass or zinc over the spindle, or if a shoulder becomes worn around the cone it is better to have the cone redressed, or renewed if necessary, otherwise the rollers are liable to be "barred" during the process of polishing.

Handkerchiefs.—The setting of the wide bore of handkerchief rollers is done by means of "collars," as explained for pentagraphing wide bore rollers, only here the collars are of a heavier make to suit the mandrel of the lathe. After the screw pins are adjusted in a rough manner the roller is turned round and marked with the thumb, as already explained, and the pins adjusted till the roller runs true.

For polishing handkerchief rollers, the lathe is fitted with a three-speed cone pulley, and counter shaft accordingly. The driving belt may be used on the larger cones, as required, in order to reduce the speed.

Sizing the Rollers.—A copper tape (flat wire about $\frac{1}{8}$ inch broad) is now pulled tightly round the roller and marked with a knife by drawing a line across one side of the tape, and also making another

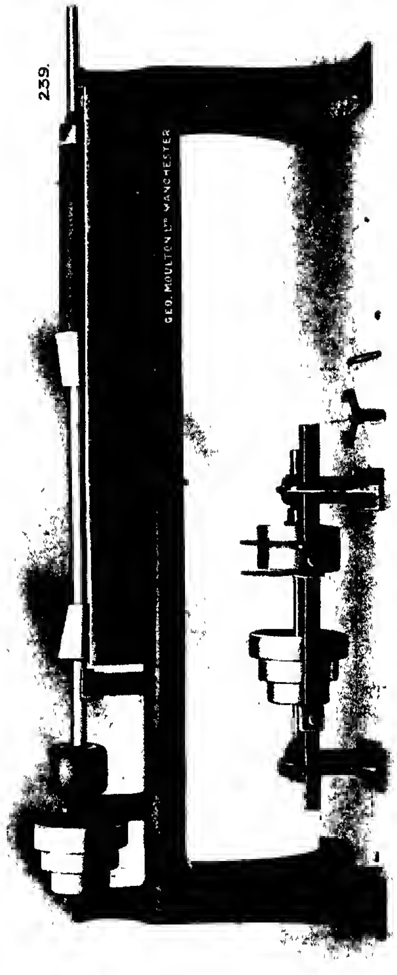


Fig. 276.—Roller Polishing Lathe

mark, one line within, on the other end, so that when the roller is polished and the tape pulled round the roller the two marks will appear as one continuous line across the tape. The tape is now tried at several places across the roller, and will at once show the parts that may require a little extra polishing. Water is now run into the trough until it touches the surface of the roller. The lathe is set in motion and a block of coarse sandstone held on the roller, gently swinging it backward and forward as it is moved, first to one end of the roller, then the other. The cording of the turning tool will soon disappear. The tape is now tried, and extra polishing given to any part that may show larger in the circumference. A block of fine sandstone is next used in the same manner, and in a quarter of an hour the surface of the roller should appear to be comparatively smooth, but lacks finish. The roller is examined, and should any holes be showing on the surface they are marked by the application of a small fingerstone with a ring around each, and plugged by the hand engraver. These are then fingered down, if necessary. The Water o' Ayr stone is now applied, having been first carefully cleaned (as all stones should be, previous to being laid on the surface of the roller). In about fifteen minutes the roller should show a well-skinned, clean surface entirely free from marks. At this stage, if a small Water o' Ayr stone is used on the roller for a few minutes from the back of the trough it helps to improve the surface. If an excess of holes is apparent, it is better to take the roller off for mending and proceed with another of the set. The copper tape is again applied in the same manner, in order, not only to ascertain that each roller is straight, but also to have all the rollers making up to a pattern of uniform circumference. Should one roller of a set be a line small in the circumference it is better to stamp it the first pitch, as it is found in practice better to have the last pitch of a set a line large, and on no account small, as it will give trouble with the fit while printing.

Scouring the Roller.—This is done by first rubbing two bathbricks together and allowing the powder to drop on a piece of wet blanket, which is then run across the surface of the roller while in motion.

Drying off the Roller.—Some water is now run out of the trough until it is below the surface of the roller. A small piece of rubber sheeting (about 4 inches square) is held against the roller while in motion, and moved across its length. This has the effect of taking away most of the water and preliminary to thoroughly drying the surface, first with a piece of packsheet, and, finally, with a handful of white rags.

"Tears" while Polishing.—During the process of polishing a small particle of hard grit or iron occasionally turns up on the surface of the stone and causes a serious "tear" or "rut" on the surface of the roller. If not very deep a rub with the engraver's burnisher will remove the defect, but it may require to be painted and the roller given a sink in moderately strong nitric acid and afterwards burnished. If the rut is extra deep it will require to be mended with the insertion of copper wire. The stone must also be examined and these pieces of foreign matter chipped out. If a vein of this nature be showing it is better to use another side of the stone. When using the large sandstone the four sides should be alternately used, and also turned end for end frequently. This method helps to keep them better in shape, and the stone will last much longer.

Polishing Rollers for Mill Engraving.—These are better not to show too glassy a surface, as the mill is more liable to slip during the process of machining. Less polishing, therefore, with the Water o' Ayr stone will suffice. The better surface can easily be secured during the several polishings which mill rollers usually require in the course of engraving.

Rollers "Barred."—This defect may arise from three causes—1st, by using too heavy a weight on the top of the polishing stone; 2nd, the roller not running true when being polished; 3rd, the bushes being worn and allowing the spindles to wobble. This defect usually extends right across the roller, and usually recurs four times in the circumference; it may be felt by laying the fingers on the roller while it is in motion. It may be better detected by passing a hollow Water o' Ayr stone across the roller. A roller slightly "barred" may be rectified by polishing with a hollow Water o' Ayr stone on a true running lathe, but if seriously "barred" it requires to be again turned off. Engraving placed on a roller which has been "barred" will show an uneven result in printing, with light and heavy stripes across the piece, especially if the work should be of a small repeat or cover nature.

Rollers for Blotches.—It is usual to complete the plain polishing with a flat Water o' Ayr stone. A point worthy of notice and of great service is where a roller of a set (always the last pitch) is going to be used for a blotch it should always receive a little polishing with a hollow Water o' Ayr stone. This has the effect of retaining a truer surface on the top of the ground when engraved. It is also advantageous for rollers having a ruling for shade lines, especially for handkerchief patterns which are designed to imitate woven effects.

Polishing Stones—Sandstone, Coarse.—These are blocks of clean

free-stone with no grit or iron particles. They are usually about 16 inches long and 12 inches square, each weighing about 50 lbs. They are first used on rollers when polishing to erase marks of the turning tool.

Sandstone, Fine.—The hones formed from this are blocks of close-grained free-stone. They must be free from grit or iron particles to avoid tearing the rollers when polishing. They are usually about 14 inches long and 10 inches square, each weighing about 40 lbs. They are used after coarse sandstone to put a better surface on rollers.

"Water o' Ayr" Stone.—It is a fine hone about 12 inches long and 6 inches square, weighing about 20 lbs. It is used after fine sandstone to "buff" or put a skin on the roller ready for engraving, and is also used to erase any "bur" on engraved rollers.

The edges of these expensive stones ("Water o' Ayr") are coated with red enamel paint to prevent water getting into the natural laminations of the stone. If the enamel is scraped off they are liable to split up.

Hollow or Saddle Stone is usually a "Water o' Ayr" stone, having an arch in the centre to suit the circumference of the roller, thereby protecting and preventing the stone from injuring the engraving.

Finger Stones.—These are pieces of Water o' Ayr stone cut with a saw to various sizes from 1 inch square and about 5 inches long to about 4 inches broad and 6 inches long. Each of them is tapered off at one end to about an angle of 45°. They are used principally for finish polishing, to reduce "mends" to the surface, erase ruling lines, and get into parts where the ordinary Water o' Ayr stone would injure grounds or the surrounding engraving.

Polishing Refuse.—This is termed "sludge" or "slime," and is the ash of the stones incorporated with the copper during the process of polishing. The troughs of the polishing lathes which require to be cleaned out frequently, are, if possible, connected with a drain running into a large tank. The thinner residue from the troughs is allowed to run into the tank, and the "caked" portion at the bottom scooped out and placed in casks. The residue in the tanks can be cleaned out as required, and placed in casks and forwarded in the moist or dry condition to the copper works, where copper is extracted and credit given for it. This forms an important item of economy, as from 20 to 25 per cent. of copper may be extracted from the slime.

Finish Polishing is the term applied to the operation where the roller has been engraved previous to being impressioned. If care and judgment are exercised, many a roller with slight defects can be

improved, but if finish polishing is done in a careless manner it will ruin the best engraving.

The roller is placed on the lathe in the same manner as explained for plain polishing, and also set perfectly true. Previous to starting, the surface of the stones should be washed, because, when laid aside, grit and other foreign matter may have adhered to the surface and be liable to injure the face of the roller. A scrubbing brush is dipped in "sours" and run across the surface of the roller. This has the effect of giving the stone a grip; otherwise it will only "buff" the surface.

Fig 277 — Polishing Lathes and Roller Racks.

Peg Roller.—Suppose it is a "peg" roller, it can be polished with the flat Water o' Ayr stone After moving the stone across the roller, or giving it a straight end, as it is termed, the lathe is stopped and the surface of the roller examined and mends fingered down if necessary. The lathe is again set in motion and the stone moved backward and forward in a regular manner across the roller until a good clean skin is shown on the surface. This should be secured in two or three minutes. The polisher should, in no instance, give extra polishing to the roller unless specially instructed.

Blotch.—To properly polish a blotch roller requires the utmost care. If the ground is well on the surface no stone should be passed over it. The ground should first be cleaned out with a scrubber, and if any particles of varnish still remain in the bottom it may be necessary to use the wire card to remove them. "Sours" are brushed across the roller (as explained for peg roller), then a finger stone used to polish away the ruling lines which are showing on the plain surface of the roller. When doing so caution must be exercised to see that the point of the stone does not touch the surrounding ground. Should a blotch be slightly under the surface, or it is desired to have more "top" on the ground, a Water o' Ayr saddle stone well fitted to the round of the roller may be passed two or three times gently over the surface to procure the desired result. Handkerchief rollers invariably require more manipulation than garment rollers for finish polishing, owing to the border, gaw, and se vedge grounds sometimes requiring to be protected from the stone, and all or part of the filling dressed up with the finger stone. Again, with two, three, or more patterns on the roller and of different designs, each may require to be treated with a differently sized finger stone. Where a series of cross-over mill lines are engraved these require to have the "burr" removed with the finger stone before a flat stone can be applied.

Each roller for finish pol shing that contains different characters of engraving should be well considered as to the most suitable methods to be adopted if the best results are to be obtained. With a little practice it is wonderful how sensitive the tips of the fingers become when grounds are touched. If the second and third fingers are gently drawn over the surface at several places across the roller one can instantly tell if the engraving is of equal strength, or one part stronger than another. This method should be adopted previous to polishing on all rollers of a ground character.

CHAPTER XXV.

ELECTRO-PLATING OR DEPOSITING.

Electro-plating.—Electro-plating is the art of coating metals with metals by means of electricity, and is based upon the simple fact that a current of electricity tends to decompose a metallic solution into its constituents, depositing the metal upon the surface prepared to receive it. To plate is to perfectly cleanse a metallic surface and to deposit the metal thereon, so that it may incorporate itself with the original surface, the result is that the article looks like copper or whatever metal may be deposited upon it.

The electro-coppering of iron shells in lieu of solid copper rollers for calico printing is no new invention. It is recorded that it was first tried in England in 1855, and again in 1862 further experiments were made, but both proved failures. The Frenchmen again experimented in 1872 and secured fairly good results. Since then it has been further improved, and is now less subject to irregularities, owing to the advanced knowledge of chemical manipulation and skill in guiding the electrical current.

The Dynamo.—To obtain the necessary current a specially built dynamo is required. A dynamo is not strictly a source of electricity. It is properly a converter of mechanical energy into the energy of electricity. It returns to us a large percentage of the force used in driving it. It returns, however, in the form of electricity.

Dynamos, as ordinarily built, evolve high electromotive force. Machines intended for electro-plating are specially designed to evolve low electromotive force or current. In an ordinary electric-light dynamo the armature is composed of a large number of turns of fine copper wire. For electro-plating the armature is composed of a few turns of a very thick copper conductor. Hence an electric-light dynamo may evolve a pressure of many hundred volts, while one for electro-plating might evolve many hundred amperes.

Volt.—The volt is the recognised unit of electromotive force = a unit of pressure = to one cell of an ordinary galvanic battery.

Ampere.—This means the current or rate of flow = a unit of

current, equivalent to the current which one volt of pressure will produce through one ohm of wire or resistance.

Dynamos as now built are specified to be capable of exerting an electromotive force (pressure) of so many volts, and to yield a current of so many amperes at a certain given speed of rotation.

Electricity has certain unvarying qualities—

1st. The unique power of drawing or attracting atoms from a distance.

2nd. It is practically instantaneous in action through a conductor at any distance.

3rd. It has the power of decomposing chemicals—"electrolysis."

The Acid Bath.—For the purpose of depositing copper on iron shells we have the large electrolytic bath, a chemical medium which is made up of water, sulphuric acid, and sulphate of copper. The base of the plating bath solutions is water composed of two atoms of hydrogen and one atom of oxygen. As water cannot readily be split up or decomposed by the action of the electrical current only, some substance of an alkaline or acid nature is added. The addition of this component apparently loosens or breaks up the cohesion which holds the molecules of water in union. We thus have water with the addition of sulphuric acid (two atoms of hydrogen gas and one atom of oxygen gas *plus* two more atoms of hydrogen, one atom of sulphur, and four atoms of oxygen). As sulphuric acid alone cannot be readily decomposed by electrical action, it follows that if too great a proportion of acid is added to the water it will tend to retard the electrical action. The proper amount, therefore, of acid is that which will promote the most rapid decomposition of water under similar conditions of electrical action.

In addition to the water and sulphuric acid sulphate of copper is added, as it would not pay to make up the necessary solution by dissolving the anode until the bath reached the proper degree of metallic sulphate density.

Sand Blast.—The importance of properly preparing the shell for electro-deposition cannot be too carefully attended to. The surface must be chemically clean; ordinary cleanliness is of no use whatever. The cause of most failures might be summed up in one word, "dirt."

The surface of the iron shell is thoroughly sand-blasted in a small room by a man wearing a dress after the manner of a deep-sea diver. An air pump is applied, which not only blows the coarse silver sand contained in a cistern through a hose at a pressure of 10 lbs. per square inch, but another tube also provides a supply of air into the helmet. This sand blast cleans the surface of the shell by taking

away any rust or corrosion in a manner not obtained by any other means.

Cyanide Bath.—After the sand blast the shell is immediately placed in the cyanide of potassium liquor, the large iron tank being deep enough to completely immerse in a perpendicular manner the largest shell. Previous to this the liquor is heated by steam to from 120° to 130° F.

The air blast is turned on, which has the effect of blowing the liquor out of the small tank into the large one and raising the level of the liquor in the large tank to the top of the roller. When the air blast is turned off the liquor again flows back into the small tank until it is on a level with what remains in the large one. It is advisable not to overheat the liquor, as great evaporation will take place and cause needless expense in making up fresh liquor and adding it to that contained in the tank.

This not only chemically cleans the shell, but, owing to the tank being surrounded with copper plates and connected up to the dynamo, a current of electricity is turned on which should register from 150 to 200 amperes on the meter, according to the size of the roller. In from ten to twenty minutes the shell should receive its preparatory and all-important, though slight, coating of copper. When taken out of the tank it is hosed down with clean water, and a blast of cold air blown inside the shell to thoroughly dry it. This is a detail, but found to be of great service in securing the gutta-percha cap at the end of the shell, and prevents the liquor entering and destroying the bore by the action of the acid in the coppering bath. The wooden plug is hammered into the bore of the roller flush with the end, and the gutta-percha ring heated and, by the weight of the shell, allowed to fix itself flush with the surface of the shell. These details, from the shell being taken out of the cyanide until ready to go into the coppering or acid bath, should be done quickly to prevent, as far as possible, dust or anything coming into contact with the shell that might impair the solidity of the coating of copper on the shell.

Another point, and worthy of special notice, is to connect the electrical current to the shell before it is dipped into the coppeting bath. This eliminates any chance of the acidity of the bath acting on the preparatory coating of copper which it received while in the cyanide tank.

The shell now in the coppering bath is called the "cathode" or negative pole. The copper plates suspended around the inside of the vats are called the "anodes" or positive poles. The anodes

are copper, a metal which can be attacked by, and unites with oxygen in its nascent state.

As soon as the electrical connections are made two actions take place, the primary one is that of splitting up the acidulated water into its constituent gases. The union of these gases with the metal of the anode, and the reaction of this newly-formed compound on the acid in the water give rise to a salt or sulphate of the metal which composes the anode. The secondary action is the liberation of hydrogen at the cathode or shell, which takes place after the primary action and the reaction which follows it. This secondary action keeps up the acid strength of the bath. There is a loss of acid, however, owing to some of it becoming decomposed, because, in practice small quantities of acid require to be added to the solution from time to time. It is of the utmost importance that the vats be fully supplied with anodes, otherwise the strength of the liquor will become impoverished. If this point is properly attended to, sulphate of copper will seldom require to be added.

Oxide of copper is now formed on the anodes, and, if deposited to a large extent, would stop the electrical action, owing to this oxide being a bad conductor, but by the electrical action sulphuric acid is also accumulated around the anodes and the oxide reacts on the sulphuric acid. The result of this reaction is the changing of places between the copper oxide and the hydrogen of the acid. It is forced out of the combination forming the acid by the oxide of copper, and we have instead a salt of sulphate of the metal forming the anode, which gradually dissolves in the bath. Two atoms of hydrogen have been displaced and replaced by an equal amount of metal in the form of an anode. This new compound is composed of the metal of the anode together with sulphur and oxygen, and is in turn united with the acidulated water forming the bath.

The cathode or roller being electrically connected acts as a magnet and draws this dissolved metal which is in suspension, and gradually builds up solid copper on the face of the roller.

Amount of Deposition.—In the application of electrical energy to the deposition of metals, it is the action which is maintained that governs the rate at which the metal is deposited. If the dynamo is working all right there should be little variation of the voltage from one unit of cathode surface relatively to the capacity of the vats or dynamo.

The voltage should remain much the same, showing that the velocity with which the electrical action is going on is about the same at every point of each square foot of cathode surface exposed to the

action of the chemical agent. At the same time, when a series of vats are linked up they ought to be equally yoked, as far as possible, not as regards number of rollers, but so far as the area of square feet is concerned. For instance, one vat may contain six rollers, say, 50 inches long by 16 inches in circumference, which gives a surface of $33\frac{1}{3}$ square feet. In another vat of the same capacity might be placed four shells, two 50 inches long and 16 inches in circumference, and two 42 inches long and 36 inches in circumference, which gives an area of fully 32 square feet, thus equalising the vats. Further, instead of running the vats light it is better to disconnect one of the vats and keep the others full. More equal results will thus be obtained.

The amount of deposition that should take place can thus be simply calculated, and providing that everything is in good working order, fair regularity can be maintained. Suppose that there were six vats (six rollers in each) about 200 square feet of cathode surface, and it took 58 hours to copper them up (continuous running) with 13 lbs. of copper on each shell, this would mean that 8 lbs. of copper was being deposited per hour.

To obtain this the meter would require to register 12 to 15 volts and 500 to 550 amperes. This quantity of deposition could be increased to fully 9 lbs. per hour by keeping the amperage up to 650, and bring the rollers out in 52 hours; but usually the shells thus taken out are much rougher on the surface, and a proportion of these would require to be sent back to the vats after being turned off owing to the defects on the surface, such as numerous holes. It is, therefore, cheaper in the long run to secure good surfaces and have a smaller proportion sent back to the vats.

Garment Shells.—These are of regular circumference—viz., $15\frac{13}{16}$ inches—and are coppered up to $16\frac{1}{8}$ inches and finished (turned and polished) at 16 inches. The following table shows the average amount of copper deposited in the vats and also left on when finished :—

Length of Shell.	Weight of Iron Shell	Gross Copper put on.	Net Copper when Polished.	
Ins	Lbs	Lbs.	Lbs	Ozs.
36	78	9	6	0
40	82	10	6	8
44	87	$11\frac{1}{4}$	7	0
48	92	$12\frac{1}{2}$	7	12
50	96	13	8	0
52	102	$13\frac{1}{2}$	8	4
54	108	14	8	8
56	116	$14\frac{1}{2}$	8	12
60	130	$16\frac{1}{2}$	9	4

These weights work out on an average of about $4\frac{1}{2}$ ozs. of copper deposited per inch of length when in the vats, and when turned and polished about $2\frac{1}{2}$ ozs. per inch ; equal to about 1 lb. 8 ozs. per square foot of surface for the finished coat of copper.

All iron shells require to be weighed before being sand blasted, also after they come out of the vats to ascertain the gross weight of copper put on, and again when turned and polished in order to record the finished weight of copper.

For electro rollers finished at 16 inches in circumference, it will be observed that only $\frac{3}{16}$ inch in the circumference is allowed between the iron shell and the finished roller, which is equal to a skin of copper $\frac{1}{32}$ inch in thickness. This is considered the minimum for safety when engraving. On this account the surface of the iron shells should not only be true to the bore, but the turning lathe should also work in the same manner, otherwise a thinner coating of copper will be on one side of the roller compared with the other, which is almost sure to end in one or other of the following disasters :—That of the engraving getting etched through the copper into the iron, after all the labour of pentagraphing the design on the roller, or the coating of copper becoming so loose from the shell during the process of milling as to necessitate turning off and recoppering from the iron.

Handkerchief Shells.—It is advisable to have the finished coating of copper rather thicker for these than for garment rollers, owing to the engraving usually being slightly deeper. The allowance of $\frac{3}{16}$ inch between the iron shell and the finished size for 16 inches in circumference works out about $\frac{1}{16}$ inch for every 5 inches in the circumference, therefore when ordering handkerchief shells this deduction should be attended to ; it would also be well to keep the finished size full, and to err on the safe side by having a rather thicker coating of copper.

Defective Coppering.—This term can be applied to various kinds of indifferent results.

1st. Rough coppering—*i.e.*, showing " barnacles " on the surface. This is generally accounted for by the density of the liquor being too strong, having an excess of sulphate of copper and sulphuric acid, and if the liquor was " twaddled " it would be found to register too high. Excessive amperes also account for this, the electrical current being too strong and rollers ready for coming out of the vat too quick.

2nd. Copper being too crisp and brittle, a sure sign that sulphuric acid is much in excess.

3rd. Spongy copper, the result of absence of sulphuric acid and

the consequent forming of an excess of oxide on the anodes. Rollers with this class of copper will usually be found to require too long a time in the vats owing to the oxide partially arresting the electrical current.

4th. Formation of "worms." These are tail-shaped from ½ to 2 inches long and partially embedded in the surface of the copper, with the result that when the roller is turned off it leaves a furrow which requires to be carefully mended; otherwise the shallow part of the copper in the furrow will become detached and necessitate the copper being turned down to the iron and the shell recoppered. These formations seldom occur, and only two or three on each roller. It is difficult to properly account for the cause of these, but it is probably due to some "caddis" or fluff getting into the vats, perhaps dropping from the roof and getting caught on to the shell and a formation of copper formed on it.

Mending Electro Rollers.—Greater care requires to be exercised by the engraver in mending or "plugging" electro than solid copper rollers. The most important point to attend to is to see that small pieces are inserted; consequently a shallower opening can be made with the chisel, which would obviate the risk of going down to the iron. When the defect is of a long nature it is advisable to insert the pieces in an angle manner rather than to attempt to "plug" the defect lengthwise.

Recoppering.—This is the term employed when engraved electro rollers are about to be used for fresh engraving.

The old pattern requires to be turned off in the same manner as for solid rollers. The process strips off about half the copper, which would then leave too little copper on the shell to proceed with the engraving.

The roller thus requires to be again coppered up to the previous size. After turning off, it is sand blasted and placed into the coppering vats without being subjected to the cyanide tank process, because there is still a skin of copper left on the shell. While sand blasting, less pressure will suffice. If the same pressure is used as in the case of the iron shell, it is liable to spring at some parts the very thin coating of copper which is still on the shell. The recoppering usually takes about two-thirds of the time originally required for coppering the iron shells, the recoppered shell should be weighed in the same manner as explained for the iron shells.

Economy in using Electro Rollers.—Regarding the question of economy in using electro rollers in place of solid copper, opinions differ. The initiatory cost is certainly much less, but if the cost of

recoppering each time the rollers are turned off (to admit of new engraving) is taken into consideration, and the expense of occasional failures when the engraving is well advanced, which requires to be done over again, as well as the roller turned down to the iron and coppered up, also the hand engraver taking a few hours longer when " cutting " a pattern, owing to all electro copper being softer and tougher than solid, there are certainly good grounds for many experienced men stating that if all these obstacles were properly accounted for there would be more economy in retaining solid rollers for all garment patterns, but adopting electro rollers for large handkerchief work, owing to the enormous expense in purchasing solid copper rollers for these.

CHAPTER XXVI.

OILS AND VARNISHES FOR GENERAL USE.

Tallow.—Lubricants in connection with engraving purposes may be varied according to the class of work on which they are used. In the etching room it is advisable to use tallow instead of oil, in order to prevent any drops of the latter from getting into the acid, or accidentally coming into contact with any varnished surface, which would cause a defect at that portion, as it would immediately drop away the moment the roller was placed in the acid, leaving the parts touched by the oil exposed to the action of the acid.

Lubricant.—For machine engraving there is nothing to equal a mixture of mustard and tallow as a lubricant for the pivots of the mill when running in the mill frame It is strange that it not only keeps them cool, but forms a good skin on the pivots, which is much to be desired. A cheap oil can be used for the wheels, but good clean oil is inperative when used on the surface of the mill.

To lubricate all points of friction on the pentagraph machine the finest sperm oil ought to be used · this prevents any clogging taking place. A cheap oil is false economy, as it readily clogs owing to the absence of a rotary motion by belt power.

With the polishing and turning lathes a cheap oil can be used to advantage, owing to the speedy rotary motion causing a friction and preventing the oil from clogging.

Oil for Transparent Paper.—This is made from bank post paper in sheets, and rendered transparent by rubbing the surface with a mixture of boiled linseed oil and American turpentine in the proportion of three parts of the former to one of the latter, and the bottle well shaken. A sheet of good thick zinc is laid on a table and a sheet of the paper laid on the top. A little of the oil is poured on the paper and well rubbed over the surface with a sponge. The sheet of paper is then turned over and more oil rubbed over the surface. It is then hung up with small hooks on a stout cord until dry, which usually takes three to four days.

A special class of transparent paper giving a more transparent

and harder surface can be made from the same material and in the same manner with a mixture of four parts of copal varnish and one of terebene. This is more difficult to spread evenly over the surface, and greater care requires to be exercised to ensure that no creases are made on the paper, which would destroy the flatness of the surface.

The paper treated in this way will be thoroughly dry in one day.

Wax for Hand Engraver.—This mixture is required for the purpose of coating heavy cartridge paper for full impressions from the roller, as also the transparent paper for repeating sketches. It is made in the following manner :—

Two and a half pounds of beeswax to 1 lb. of tallow is weighed out and placed in a pot over a gas ring: when melted, about 2 ozs. of rosin may be added. It is then poured into paper tubes about $1\frac{1}{2}$ inches in diameter, which form handy sticks for using the wax. To ensure it being slightly harder during summer a little less tallow should be used.

Wax for Clammers.—This is made after the same manner as wax for the hand engraver, with equal proportions of beeswax and tallow. When melted 2 or 3 ozs. of pentagraph varnish is added, which colours it brown, and also acts as a resist to the acid when the wax is used on the surface of the mill.

Rosin Varnish.—This varnish is used by sketchmakers, plate cutters, and hand engravers for transferring impressions.

One lb. of rosin and 5 gills of turpentine are placed in a pot, set on a gas ring, and gently heated until the rosin is dissolved. More heat is applied and the ingredients boiled for five minutes, then poured into a jar.

In using the varnish it should become slightly tacky in about two minutes when spread over the plate or roller. It inclines to thicken after lying some time, but this can be rectified by adding more turpentine and shaking the mixture.

Painting Zincs.—Good clean No. 9 sheet zinc, 8 by 3 feet, is purchased, and coated with white lead made up as follows :—1 lb. of white lead, 1 oz. of terebene, 1 oz. of boiled linseed oil, adding turpentine to the required consistency.

To procure an extra smooth surface it is usually poured on the sheet which lies at a slight angle against a board. The excess paint runs into a conductor (fixed at an acute angle), and thence into another vessel.

Another form of coating the zinc, which has the advantage of being non-poisonous, is painting it with zinc white, but it does not

give the same body on the surface. The white lead method is, therefore, still preferred.

When the sheet is cut to the sizes required the surface is rubbed over with fine emery cloth, thus making it much smoother and sweeter for tracing with the pencil in the opaque camera.

Naphtha.—For use in the hand and die departments as a cleanser this is preferred. Naphtha is not only more economical, but also acts quicker, being more powerful than turpentine.

CHAPTER XXVII.

NEWER DEVELOPMENTS OF ENGRAVING AND PRINTING.

Hindrances to the Newer Methods.—The development of new methods with a view to cheapen engraving and printing in the calico trade has been slow, not solely on the engraver's account, but partly because of the fastidiousness of many merchants. They did not give the engravers any encouragement to persevere in their experimental endeavours, which were first made (to the knowledge of the writer) about twenty years ago, to place on the market not only a cheaper class of engraving, but also to get at methods of producing the engraving much quicker. These would have greatly assisted them in being able to "market" printed calico in less time than is done at present.

With the abnormal advance of photo-engraving for book and newspaper illustrations, it became more apparent than ever that perseverance alone would break down this unwarranted prejudice.

With that object in view various methods have more recently been experimented with.

The greatest difficulty the engraver has to contend with is the comparatively coarse fabric to be printed upon compared with a smooth surface paper. Further, the exactitude demanded not only of the joinings for the multitudinous repeats of many of the designs, but also the perfection of the equal strength demanded for each repeat or unit renders difficulties that are not easily overcome.

"Process" Experiments.—The earliest attempts at "process" work were of a pictorial nature (say, the centre of a handkerchief) with a view to save the great amount of labour which such a design incurred when engraved by the hand method.

Drawing and Transferring.—A sketch of the subject was drawn on transparent paper with a special lithographic ink, the surface of the roller perfectly cleansed, coated with a varnish, and, when dry, the sketch was transferred (by rubbing the back of the paper) on the surface of the varnish. The roller was then warmed sufficiently to melt the transfer only, the surface was now rubbed over with

turpentine applied with a piece of soft white cloth, which cleared the parts as drawn and left the surrounding surface still acid-proof.

Etching.—The roller now ready for the etching trough, nitric acid of moderate strength was first used to give a slight " break " or etch, and then placed in a trough of iron perchloride solution to give the required depth to the engraving without etching the line too broad.

The result of this method was very uncertain from various causes. If the drawing was uneven or the sketch unevenly transferred, it reproduced the defect on the engraving. Again, if the roller was overheated the line was unduly thickened, or if overwashed with turpentine the transfer was ruined.

Notwithstanding all these risks many creditable jobs were produced, and with essential parts being stopped out during the process of etching, and afterwards touched up with the graver, it saved a vast amount of time in hand engraving.

Repeat Patterns.—A further development of these experiments led to the method of treating repeat patterns on garment rollers, by making a unit or one repeat in relief and etching the same on a piece of zinc, taking impressions therefrom and transferring them all over the roller.

The chief difficulty here lay in getting all the transfers equal in strength.

Polytype.—To overcome this a machine named the " polytype " was constructed and patented by the Messrs. Ker of the Process Engraving Company, Glasgow. The various sketches or units are pitched after the manner of the present pentagraph machine, which secures perfect register and types the transfers in lithographic fashion to ensure equal transfers.

To further improve the work ruled screens were tried to cause a " hatching " of the solid shapes, also a pin screen for *ombré* work. Again, a method of placing in grounds for solid shapes was found to give better results, this being an essential point for successful printing to prevent the colour from unduly flushing on the face of the cloth.

With these improvements of detail, combined with the precision of the polytype machine there is no reason to doubt that this method will yet have an important place in cheapening and producing quicker intaglio engraving for calico printing. This is found to withstand the most tear and wear and still allow the same rollers to be used for the many varieties of processes which the cloth may be put through after printing.

Lithographic Printing on Cloth.—A newer method of printing on cloth by an entirely lithographic process, invented and patented by the Hayes (Universal) Printing and Machinery Company, Limited, has quite recently been introduced.

The principle involved is that of printing lithographically upon the fabric with litho or oil colours and dispensing with the customary practice of "fixing" the colours after printing, which is essential when aniline or allied colours are used.

The actual process is continuous as in ordinary calico printing, but instead of ordinary copper rollers being employed for the impressing of the pattern the effects are obtained by the use of continuous metal plates or tubes upon which the designs are "transferred" directly in the manner customary in ordinary "lithographic" printing on paper.

It is claimed to be much cheaper, for as soon as an order is completed from any given design the rollers can be cleaned and fresh patterns immediately transferred thereon.

If a repeat order is booked the stock metal plate upon which the pattern was originally drawn is utilised and sufficient transfers made to cover the periphery of the pattern roller. They are then patched upon a sheet in such a manner as to "register" one with the other, and to make a faultless joining, and afterwards transferred to the various printing rollers.

Our practical readers will at once see that this system is limited to "print-on work."

With this lithographic process no details are given as to the cost of producing the rollers ready for printing, also how many pieces of cloth can be printed from the rollers before the transfers require to be renewed. This is an important matter as regards expense, because we fear that even with the pressure necessary to transfer the ink to the rough surface of the cloth it will tend to gradually flatten and spread the transfer on the rollers, and, therefore, after a limited quantity of cloth is "run off" the printing at the finish will show heavier than that done on the first piece.

Cost of Engraving per Piece Printed.—With ordinary calico rollers it is no uncommon practice to print off 600 to 1,000 pieces each of 30 yards before the intaglio engraving requires to be repaired, which can often be done at the cost of a few shillings (as explained in previous chapters), and in a short space of time rendering them as good as new.

Suppose an ordinary two-colour pattern costs 50s. to engrave, it would, therefore, work out at an average of 2d. per piece if only

300 pieces were printed, and 1d. per piece if 600 pieces were run off. It is further known that at many print works the cost for engraving runs out at an average of about 1d. per piece of 30 yards.

Even with the initiatory cost of electro rollers, and the subsequent

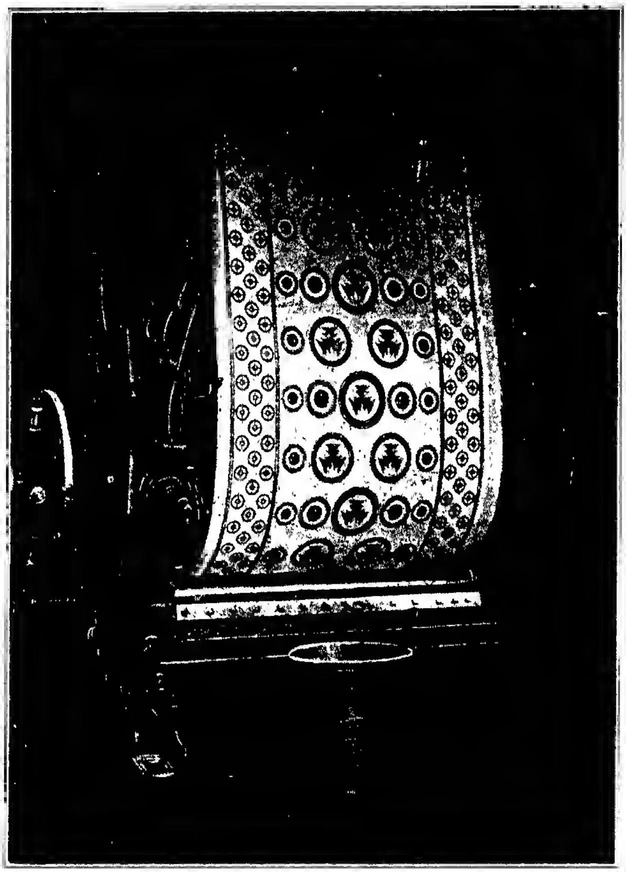


Fig. 278.—Printing Machine

small cost for recoppering to engrave a fresh pattern on the rollers by the present method, the "Hayes" process must be extraordinarily cheap if the pattern rollers can be produced and kept in perfect working order at a lower cost than the examples mentioned.

The intaglio method of engraving is ideal for giving superpose effects by one colour falling on another, many a rich and pleasing effect of seven colours being produced from four rollers.

Polymill System.—With the adaptation of the "polymill" system on the polytype machine—*i.e.*, engraving the die and raising the mill (as explained in Chapters XIV. and XVI.), then running on one repeat with the mill at the end of the roller, taking transfers therefrom and repeating them across the roller in the polytype machine (to ensure perfect register), then etching to about the desired strength, and, finally, running the mill once through the engraving to make all repeats perfectly even—is an innovation which will cheapen the present most expensive but finest class of work suitable for cloth printing—viz., mill engraving.

"Claims."—If the severe drian on the profits of the present methods of calico printing—viz., "claims for allowances" which are made and granted for the slightest blemish or so-called "off shade" in colour—were to some extent abolished, then a skilful and artistic, though worrying, trade would undoubtedly flourish by receiving its just reward in the shape of reasonable profits.

CITY AND GUILDS OF LONDON INSTITUTE.

DEPARTMENT OF TECHNOLOGY.

ENGRAVING FOR CALICO PRINTING.

FINAL EXAMINATION.

Thursday, 2nd May, 1912.

1. (*a*) Briefly describe a practicable design. (*b*) Give setting of the 4, 7, 11 pins showing repeat. (*c*) State what class of work should be done by mill and by pentagraph. (*d*) Give example of a handkerchief plan, with registers marked on same. (25 marks.)

2. (*a*) What class of work is most suitable for hand work? (*b*) Describe a design most suitable for photography. (*c*) State the chemicals generally used in photography, and the use of each. (20.)

3. (*a*) Under what conditions can allowances be dispensed with in zinc cutting (name colourings)? (*b*) Name allowances for the various styles of work. (*c*) Give the hundredth parts in the various allowance gravers. (*d*) What is meant by Zigging, and when is it applied? (25.)

4. (*a*) What style of pentagraph machine is best adapted for handkerchief work? (*b*) Name a few of the grounds generally used in part etching, also the finishing ground for same. (*c*) What is the object of part etching? (20.)

5. (*a*) Describe the methods, taken in order, of facilitating stippling. (*b*) What effect would chocolate stipple have falling on yellow, also red falling on green? (*c*) Describe setting out roller. (25.)

6. (*a*) Name and state the advantages of an acid that has been much used of late for etching. (*b*) What pins are generally used for traverse work? (*c*) What acids are used in etching dies? (*d*) Describe the raising of punch shapes, etc. (20.)

7. (*a*) Name the metals generally used in dies and mills. (*b*) Describe the raising of mills and the process of case-hardening. (*c*) What is meant by resinking, and what is the nature of the work that requires this treatment? (30.)

8. (*a*) Arrange gearing for slash line, 1 in. in 36 ins., also 2½ ins. in 36 ins. (*b*) What styles of work are done by spiral motion? (*c*) What styles are done by bumping? (30.)

9. (*a*) What were the earlier methods of applying varnish to the roller? (*b*) Name the various ingredients and the proportions used in making varnish. (25.)

10. Describe (*a*) the mending of a cut on a roller, and (*b*) the treatment of a sink. (*c*) Name the various stones used in polishing, and state in what relation they are used. (30.)

11. Briefly describe the method of (*a*) hand and machine impressioning, (*b*) preparing the cloth. (*c*) Name one or two compound colours and the shade they produce. (25.)

12. (*a*) What are the principal items to be considered in making up the cost of a job? (*b*) What oncost would you reckon on? (25.)

THE ROYAL TECHNICAL COLLEGE, GLASGOW.

DEPARTMENT OF TECHNICAL CHEMISTRY.

ENGRAVING FOR CALICO PRINTING.

FINAL EXAMINATION.

3rd April, 1913. • 7.15 *to* 9.45 *p.m.*

(*Seven* questions only to be answered. Nos. 4, 7, and 8 must be attempted.)

1. Explain how a roller that is outlined by the hand engraver would be ruled for the blotch, painted, and etched.
2. Show skeleton plan of three patterns on the roller—double hem.
3. Suppose you had four classes of engraving—pentagraph, hand, process, and mill—explain how you would grade them as regards quality, also state reasons why.
4. With the sprig supplied, show it set as a 2-and-2 row (French mix), also set as 3 positions in width, step $\frac{1}{3}$.
5. Explain how a new graver (say a No. 4 single point) would be prepared ready for working by the hand engraver.
6. Describe briefly the construction of the opaque camera, also how it is used.
7. The cutting of cloth supplied was engraved by mill (penta-die). Briefly explain how this would be accomplished, including clamming and machining.
8. The engraving on a handkerchief roller is found to be worn down, and some cross-over lines badly dipped in the printing. Explain how this roller would be repaired.
9. Briefly describe the construction of the flat table pentagraph machine, and state how the reducing motions are obtained.
10. Explain how the following tools are used:—Sketchmaker's $\frac{1}{60}$th part scale, plate-cutter's drill bits, and hand-engraver's drag.

THE ROYAL TECHNICAL COLLEGE, GLASGOW.

DEPARTMENT OF TECHNICAL CHEMISTRY.

ENGRAVING FOR CALICO PRINTING.

FINAL EXAMINATION.

4th April, 1912. 7 *to* 9.30 *p m.*

(*Seven* questions only to be answered. Nos. 3 and 9 must be attempted.)

1. Describe how a garment roller is "turned," polished and varnished for the Pentagraph Machine.
2. Briefly describe the construction of the Mill Engraving Machine.
3. Show setting of sprig "tossed" on a four-diamond pin, also the same sprig "tossed" on a four-on angle setting.
4. Explain how the following tools are used in connection with Hand Engraving:—Chisels, drag, traverse pins and stipple punch.
5. Explain briefly how a design is photographed on to the plate direct. (Name chemicals only: no quantities need be stated.)
6. Describe how tracing, also grounding, is accomplished in the Cradle Pentagraph Machine.
7. The cutting of cloth supplied is supposed to be engraved. Explain how the rollers are impressioned to show the finished work.
8. Describe how a mill is "clammed" from a round die, also a flat die, and afterwards case-hardened.
9. Describe how a fine pentagraph engraving (garment roller) is etched with the following grounds:—Part etch 12 ground, fine ground 28, and shade effect 85 lines to the inch.
10. In what manner does a die-maker cut through a ground on the die after etching? State what precautions can be taken to ensure that it is all slightly under the surface.
11. Explain why different allowances are placed between colours in plate cutting, and name the gravers used for, say, fine garment allowances, also coarse handkerchief work, each at five and three enlargement.

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